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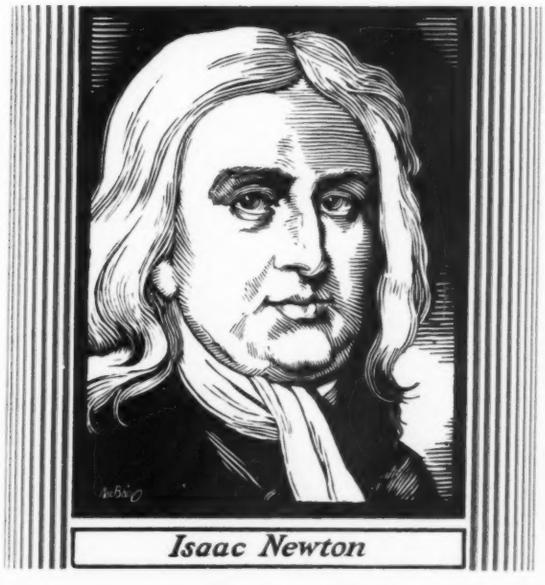
MAY 1933

MACHINE DESIGN



Isaac Newton

AS IT AFFECTS

ENGINEERING—PRODUCTION—SALES

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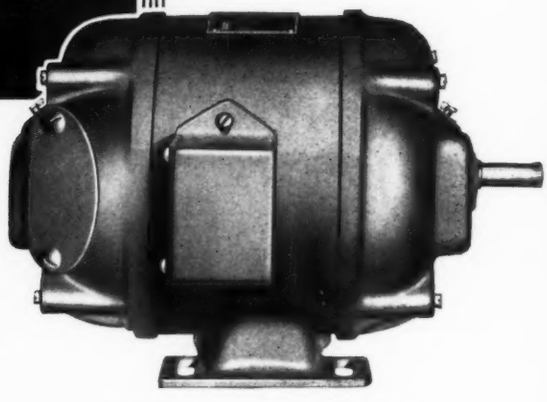

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FEW of the Master Designers whose biographies have been sketched in MACHINE DESIGN have confined themselves to a single notable invention or even to a single industry. These leaders knew that all designs possess similar basic points and that every phase of design can learn from every other phase. MACHINE DESIGN disseminates information on materials processes, parts, mechanisms and machines so that the engineer responsible for design may profit by the data available and by the facts his brother designer has uncovered, even though their respective machines may be intended for entirely different purposes.

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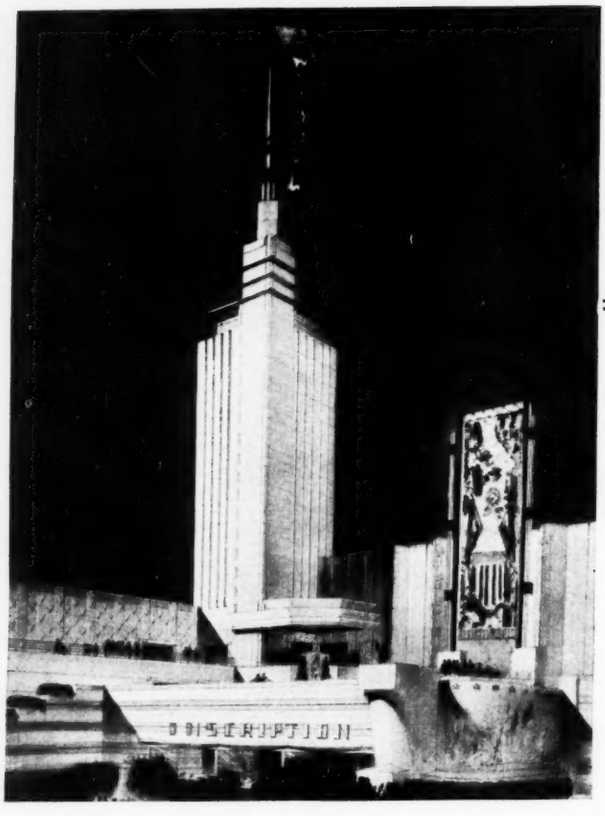

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MACHINE DESIGN

THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO

May, 1933 Vol. 5—No. 5

Adapting a Pre-Beer Machine to Present Requirements

By George J. Hewlett

Manager, Cleveland Union Engineering Co.

PRONOUNCED engineering and design development has taken place since prohibition went into effect almost 14 years ago. Machines and ideas in fields that employed apparatus similar to that of the brewery industry have changed to keep pace with progress. Consequently when breweries went into production recently with legalized 3.2 beer they were not obliged to resurrect obsolete equipment. During the prohibition era various allied fields including the carbonated beverage and dairy industries afforded a continuous market for up-to-date equipment in the form of bottle making, filling and washing units. Thus with modern design trends preserved in this class of machinery it was not in many cases difficult to adapt certain of these machines to brewery requirements. The beverage bottle washing machine, Fig. 1, is a case in point.

In building a unit of this type several major considerations confront the designer. Because it essentially is large equipment, reduction of weight is an important factor and wherever possible those parts which formerly were cast are built up from shapes and plates by riveting and

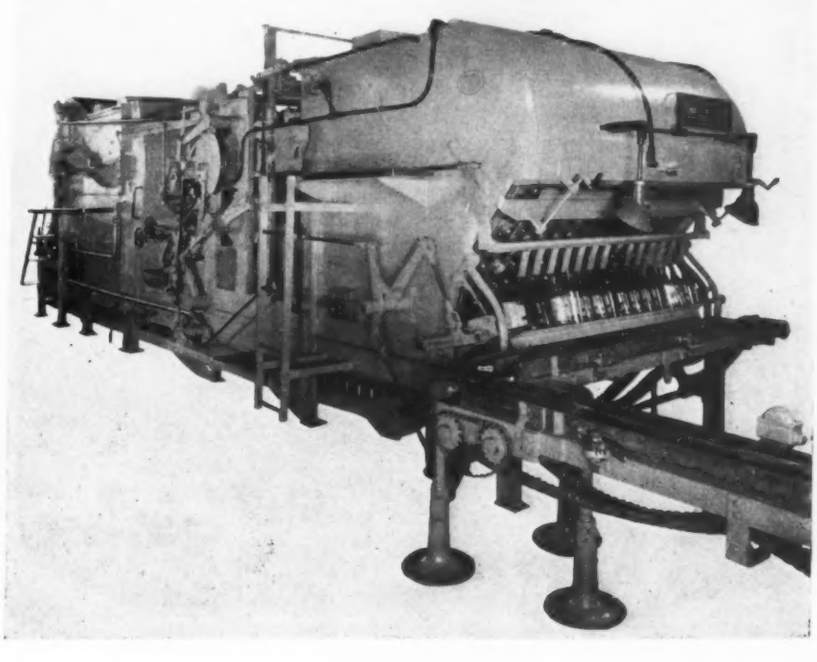


Fig. 1—Reduction of weight and automaticity in operation have been primary considerations in the design of this bottle washing machine

welding. Assembly is another feature to be taken into account inasmuch as the size of the machine dictates that it can best be shipped "knocked down." By keeping in mind accessibility of parts the mechanics who reassemble the machine at its destination, and the operators, are aided in their respective tasks. In designing such units as the brushing and rinsing mechanisms, the tank compartment and the bottle discharge arrangement as subassemblies, the erection of the complete unit is facilitated.

Motorized Reduction Units Employed

Automatic in the synchronization of operations, each of which performs a different function in the process of conducting bottles through various steps of cleaning, the bottle washing machine in Fig. 1 was developed by engineers of the Cleveland Union Engineering Co. To eliminate clutches and gear trains for transmission of power from one point to another, motors with built-in speed reduction units were employed to drive the brushes which perform an important part of the cleaning job.

From the main driving motor the driven pulley of a variable speed device transmits power through shafting to worm *A*, Fig. 2. Through crank arm *B*, which imparts motion to a slotted lever keyed to shaft *C*, a backward and forward motion is given arms *D*, Fig. 3. Motion of these arms is transferred to the chain pushers dogs *E* on both sides of the machine. The crank mechanism is so designed that during 60 per cent of the cycle the conveyor chain carrying the bottle pockets is stationary to allow for loading, discharge, external and internal brushing, etc. Four of these chain pusher dogs, two on each side at the front and back of the unit, drop their forked ends behind rollers of the conveyor chain *G* as the slotted lever swings in a semi-circular path. The pushers are located at the two different points to reduce strain on the chain, which would occur if the driving arms were concentrated in one place. When the slotted lever on crank arm *B* reaches the extreme point of its travel the dogs are drawn back, ready to engage subsequent links of the chain.

Bottles are loaded automatically in pockets of the bottle carrier. This carrier is made of pressed steel channel sections, the ends being riveted to lugs which in turn are bolted to the links of the endless chains *G*. These chains ride in tracks around the top, ends and bottom of the machine structure.

Levers Raise Bottle Feed Board

In loading the machine, bottles are placed top down on the feed board at the extreme end of the unit. This feed board is raised through a system of levers, Fig. 2, having connection with arm *H*, which is actuated by a lever on the opposite side of the unit through an arm on shaft *C*. An adjustment is provided for the feed board to compensate for wear which might permit the pockets to become out of center.

The first step in the cleaning process is a pre-

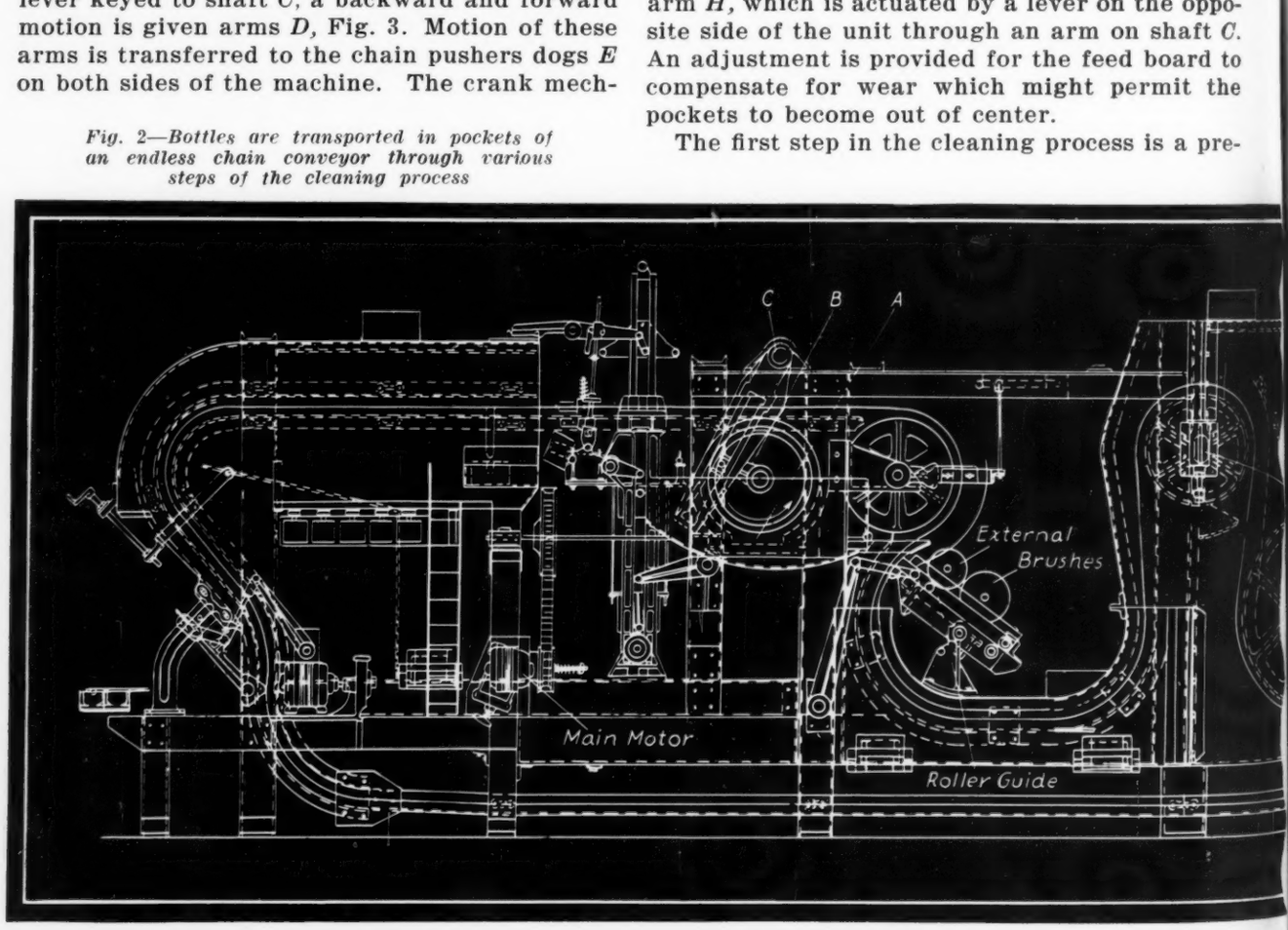


Fig. 2—Bottles are transported in pockets of an endless chain conveyor through various steps of the cleaning process

rinsing with reclaimed water after which the bottles are rinsed internally and externally as they pass over pressure jets. Subsequently they are carried into a tank containing a heated caustic solution. After they emerge from the soaking tank and the cooling tank the bottles are ready for the outside brushing operation.

In order to accomplish a thorough external brushing the bottles must leave the pockets of the carrier. Prior to their transfer to the external brushing mechanism, Fig. 3, that portion of the carrier holding the bottles travels upwardly and outwardly, in which position the bottles are inclined to slide out as they reach the tilted end of the brush frame. Here they are free to leave the pockets and thereupon slide on to revolving brass rollers and are lowered by gravity under external brushes shown in Figs. 2 and 3. Power for the outside revolving brushes is provided by a geared head motor.

Lever *L*, which contacts the face of the brush carriage or main cam, is connected through levers to the sliding bottle carriage of the brush frame. The shape of the cam is such that the carriage is caused to slide up and down allowing the bottles to slide past the brushes during cleansing and returning them to chain pockets thereafter.

A safety device is employed in connection with the external brush mechanism to prevent breakage of parts in case of maloperation. It is installed on the safety bar, Fig. 3, which forms a part of the linkage connecting lever *L* to the external brush carriage. The safety block on the bar is the connecting means for lever *L*. This block is held to the safety bar by a roller integral with the block, the roller being retained in a slot in the bar by the tension of a helical spring. During normal operation the block is held securely in place but if a bottle should break or other obstruction occur to interfere with the operation of the brush carriage, the upward movement of lever *L* forces the roller out of the notch, permitting the block to slide freely on the safety bar, thus averting breakage of parts.

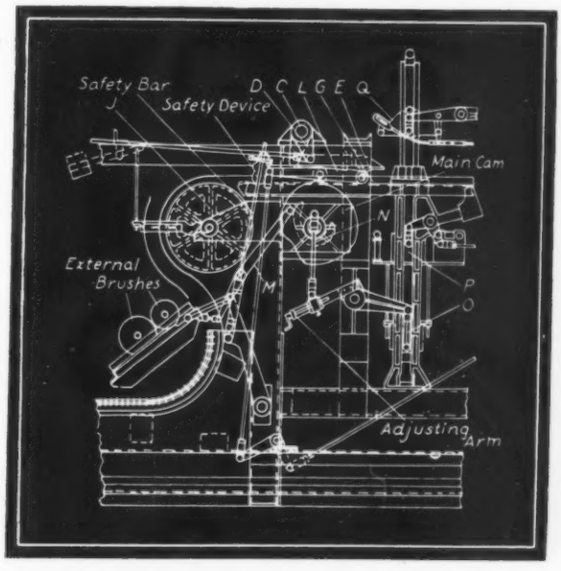
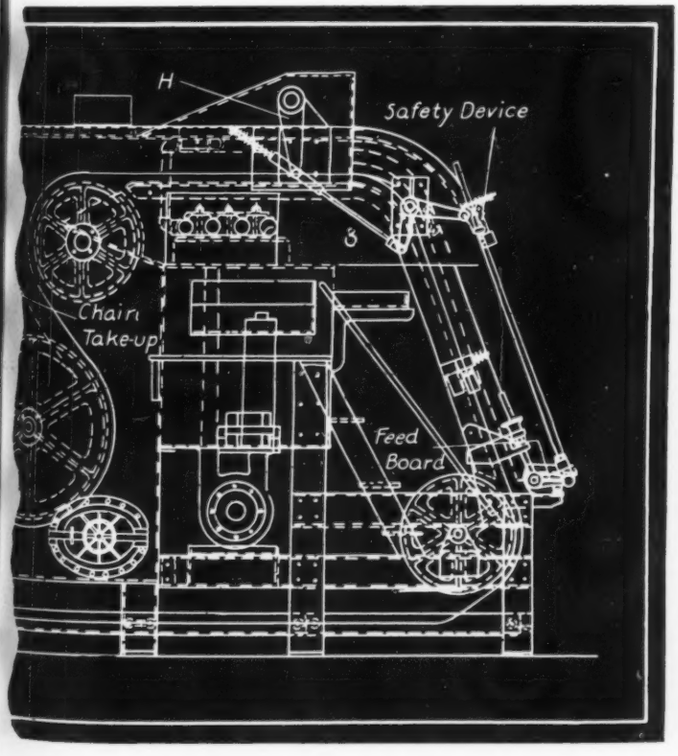


Fig. 3—Section showing safety device, cams and levers for actuating external brush carriage

As the block slides upwardly it releases an electrical switch which is positioned directly below it on the safety bar. This switch shuts off the current to the main drive motor and stops the machine. Operation of the switch, shown in Fig. 4, involves the use of a plunger which is held in a depressed position so long as it abuts against the end of the block on the safety bar.



Spring Actuates Plunger

As soon as the block moves up, however, the plunger is snapped out by the pressure of a spring through which it passes. The locking finger engaged by the end of the plunger consequently is released and the contact bar is free to revolve through 30 degrees. This rotation is effected by another spring shown at the right in the lower view in Fig. 4. When the contact bar rotates, the circuit through the contact strips is broken and the motor shut off. By depressing the resetting arm and returning the safety block to its original position against the head of the plunger the switch again becomes a safeguard against maloperation. Similar safety devices are used in connection with the bottle feed board

and internal brushing mechanism.

When the bottles have been re-inserted in their pockets after external brushing, an apron of sheet metal directly above the brush frame serves to hold them until the carrier, which then is passing over wheel *J*, swings them into a relatively vertical position. Following an internal pressure rinsing the bottles are carried to the internal brushing mechanism. Assembly *Q* equipped with plungers engages the tops of the bottles to hold them from rising out of the pockets as the holders on the carriage *P* move upward to engage the open ends. A cup-shaped centering head cushioned by a helical spring holds the bottles firmly in position as the brushes mounted on the ends of spindles rise up and are inserted into the neck of each.

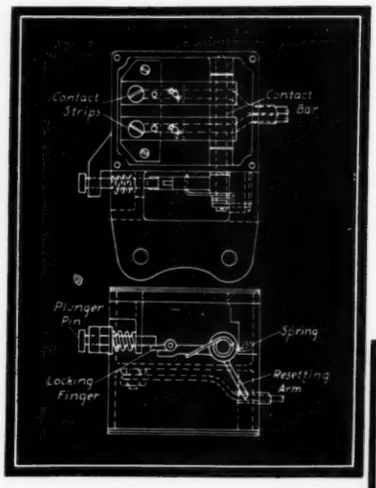


Fig. 4—Details of safety switch by which circuit of main motor is broken to stop machine when malopcration occurs. As long as plunger is held in depressed position contact is maintained

Internal brush driving assembly *O* is raised and lowered through a crank arm *N* mounted on the main cam, and a system of levers. Lower cup holder and the brush spindle gearcase are counterweighted to facilitate ease in movement up and down. The brush spindles are driven by a motor with built-in speed reducer. Water for the internal cleansing is conducted to the brushes through hollow spindles which have connection with the water channels in the gear box.

To change the position of the brush driving assembly *O* to accommodate different sizes of bottles, an adjusting arm, Fig. 3, is provided. This mechanism is comprised of a flat bar on which is mounted a sliding block controlled through a screw and hand crank. By changing the position of the block to which crank arm *N* is attached, the stroke of the crank mechanism may be lengthened or shortened.

At the completion of the internal brushing operation the bottles are transported toward the discharge end, the interval being utilized for outside and inside fresh water rinsing and to allow them to cool and drain. As they approach the discharge arrangement metal fingers retard their egress from the pockets. An auxiliary bottle lowering mechanism controlled through levers from the lower cup holder allows the bottles to slide gently on to the table.

While Fig. 2 shows the variable speed transmission in position as one of the essentials of the main drive, a more detailed layout of the assembly is depicted in Fig. 5. Variation in the speed of the machine is obtained by changing the diameter of the motor pulley, this being accomplished through a handwheel which slides the motor on its base. The pulley is composed essentially of two flanges, one fixed rigidly to, and the other mounted slidably on the motor shaft. A spring interposed between the end of the motor shaft and the sliding flange *F* maintains the sides of the pulleys in effective driving contact with the belt. When the motor is moved outwardly on its base the tension of the spring is overcome, and the sliding flange moves along the motor shaft. This reduces the effective diameter of the pulley and thus gives a lower ratio between the driving and driven elements.

Because one flange is fixed the belt would have a tendency to override it if the motor were adjusted along a line parallel to the drive. To obviate this the motor is mounted on a base which is set to slide at an angle of approximately 12 degrees. In other words the motor moves sideways to maintain the correct centerline.

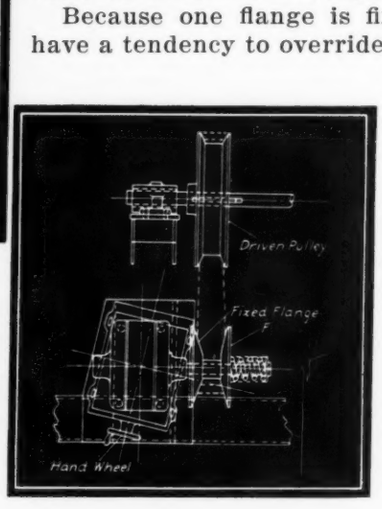


Fig. 5—Variation in speed of the machine is accomplished by sliding the main motor on its base, thereby changing the effective diameter of the driving pulley

In the evolution of the bottle washing machine one of the most striking design changes has been the reduction of weight. When it is considered that present units weigh from twenty to fifty thousand pounds some idea can be gained of the importance of solving this problem. It was primarily the replacement of castings by welded parts that made the lighter unit possible. Cast parts formerly were employed in the midsection of the machine to support the driving and leverage mechanisms, but channels, angles and steel plates now are used. It has been found also that these afford structural rigidity to the frame of the machine, thereby allowing a lighter outer plate to be utilized.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Appearance Governs First Impression

SINCE the artist has put aside his temperamental complex and accepted the habits and customs of the mechanical world he is finding new inspiration which brings excellent returns. Today he is known as an industrial designer who is able to contribute the magic touch known as sales appeal. Of course not all industrial designers had idiosyncrasies to overcome. The industralist many times was to blame but today the attitudes of both toward each other is rapidly becoming adjusted to a keen spirit of co-operation. Each has something the other needs.

Speaking of the liaison between the manufacturer and industrial designer, attention is called to the new Toledo public health scale, Fig. 1. Here is an outstanding example of designing for marketing appeal and mechanical efficiency combined. In a single year the sale of the new design equaled the total sales of the former design over a period of ten years. And in addition the scale received first award in the 1932 Art and Industry exhibition in New York.

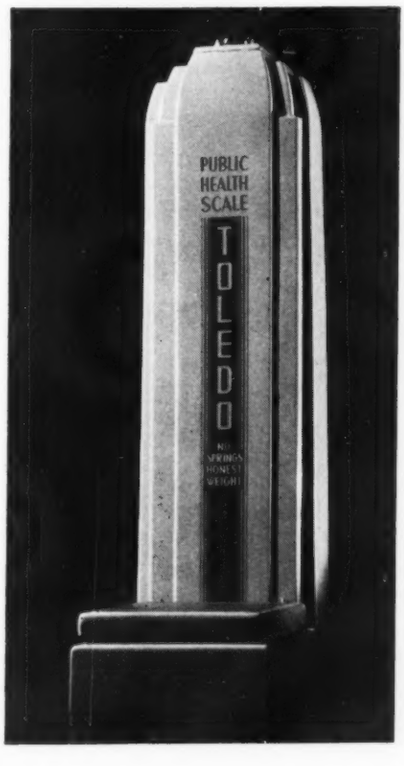


Fig. 1—This prize winning design represents the co-operative efforts of the engineer and the artist

Industrial designers and engineers worked together from the start on the new creation. At the outset it was decided that the new model must occupy less space than the old. Also women had objected to the old scale because the large dial reveals their weights to passersby. With these known facts before them they laid out the unit. It was difficult to achieve compactness because the usual Toledo pendulum mechanism lifts the counterweights outwardly. Therefore to obtain a narrow column the pendulums were given a reverse swing inward across each other at the suggestion of the artists.

Since women prefer weight secrecy a hooded indicator is employed. The coin is dropped into the carrier, withdrawing the shield over the indicator and making an electrical contact that illuminates the exposed chart or annular dial.

Flame Machining Raises Production

REDUCTION of speed to increase production might seem, and in some cases would be, illogical, but here is a specific instance where it was done. Flame machining (M. D., Feb.) made it possible. The case deals with the conversion of an old boring mill into a boiler head trimming machine, Fig. 2., and is related by M. W. Elmendorf, responsible for the application at the Pfaudler Company's Rochester plant.

Manufacturers who press boiler heads or fabricate tanks with boiler heads have found it a difficult job to square up the top edge of the boiler head flanges. The old method on the boring mill consisted of drilling a hole in the center of the head through which a clamp bolt could be inserted to tie it down to the form on the mill table. Then a slow tedious process of trimming down the irregular flange was carried

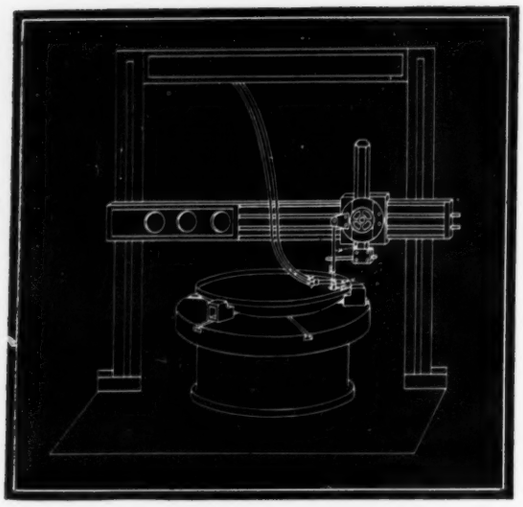


Fig. 2—Flame machining made possible reduction of speed with increase in production

on by means of a high speed tool bit. Average production on 60-inch heads was about one per hour.

Flame machining served to bring about a new method which effected higher production at slower machine speeds. An oxyacetylene cutting torch was attached to the old tool head, the holder having been made adjustable for various angles so that the boiler head could be beveled for butt welding to a ring, or cut straight through for laps or riveted work.

Another advantage of this plan is the reduction in size of operating motors. The original 15 horsepower direct current motor was discarded. In the pit a 3-horsepower backgeared motor was installed and belted to the large driving pulley on the cone. By employing this low speed unit, hooking the belt on the lowest step of the cone pulleys, and operating the mill in back gear, it was possible to slow down the table speed to one revolution in 13 minutes. A practical cutting speed of 32 inches per minute on 5/16-inch plate was attained and an average of three 60-inch heads could be turned out in an hour.

Fan's Whirl Is Quieted

OBJECTION long has been registered to the hiss of the air stream in electric fans. This noise while not intense is monotonous and particularly perturbing in rooms where a fan may be regarded almost as standard equipment in the hot summer months. The engineering laboratory of General Electric Co. set out to overcome this noise and succeeded, the new type of fan, Fig. 3, based on principles radically different from those apparent in its predecessors, resulting.

Blades, of which there are three, are wide and so overlap that in viewing the face from the front it is not possible to see between them. They are so curved that as the blades whirl, the current of air is not given a rapid and abrupt series of pushes but is uniformly and silently speeded forward.

As the illustration reveals, the unit is modeled along graceful lines. The motor is enclosed in a streamlined torpedo shell, which serves also as the hub for the fan blades. Center portion of the guard is omitted and the base is oval in shape and has a gracefully curved supporting column with a hinged joint. An oscillating fan embodying the newly designed blades also has been developed. The oscillator, which swings the fan through an arc of 80 degrees, has a friction clutch that allows the unit to continue to operate without upsetting if some object should prevent its oscillation. This unit exemplifies the work of the laboratory in embodying further refinement in machines.

Fig. 3—New type of fan, the blades of which overlap, is noiseless

Research Uncovers New Spark Plug

EXPERIMENTAL work in the development of a new spark plug provides an interesting paralled to the efforts of engine designers. These indispensible elements are as vital to engine performance as the valves and pistons. A lesson is to be gained from the unique manner in which the problem of preventing fouling was studied and solved.

Carbon which forms on the tip of any spark plug core is of a crusted nature, caused by the fact that the tip is more exposed to the inside of the cylinder and gathers a certain amount of oil particles. It also is found that this carbon is inclined to be more moist than the carbon which

forms on the insulator core up toward the shoulder. When the two carbons meet, fouling of the plug is commenced.

In conducting experiments to produce an improved plug, engineers of the Champion Spark Plug Co., Toledo, O., devised a thermocouple plug (left, Fig. 4). This consists of the shell of a conventional plug with a thermocouple built into the core. Two wires, platinum and platinum-rhodium were welded together at the

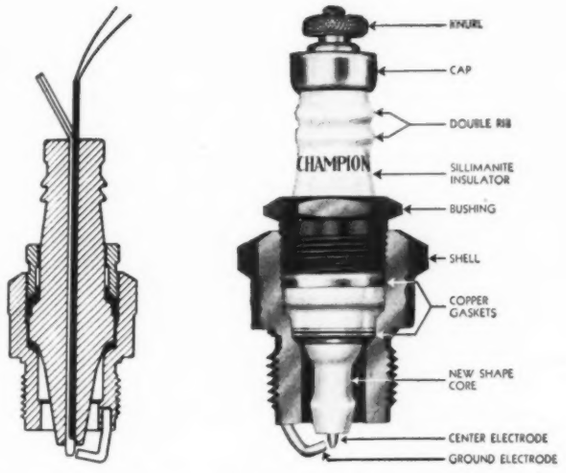


Fig. 4—Experiments with the thermocouple (left) led to development of a nonfouling spark plug (right)

end and threaded through a tiny sillimanite tube which then was placed in a groove cut in the electrode wire. This was assembled in the insulator and cemented in place. For testing purposes the couple may be positioned according to the point where it is required to determine the temperature. Ends of the wires were connected directly to a pyrometer which gave temperature readings.

Tests led to the development of the new necked core type of insulator (right, Fig. 4). With this type the tip temperature is between 1300 and 1350 degrees Fahr., while the intermediate temperature runs between 1100 and 1150 degrees. The tip temperature is low enough to prevent pre-ignition while the range of temperatures mentioned for the intermediate point is high enough to eliminate danger of fouling. Repeated tests revealed that while the tips still would gather carbon there was a point just above the neck in the core that was free from it.

Sub-Zero Freezing for Shrink Fits

NOT only is dry ice being used in domestic refrigerators but industry is finding ready application of it to contract metal parts for tight fits. In the dry ice box a 20-pound cake of solid CO_2 placed in a cooling dome on the top of the unit will keep it cool for a week. In industry the shrink fitting of parts such as cast iron liners for auto cylinder blocks, exhaust rings, rig parts and bridge pins is being accomplished by packing them in dry ice refrigerators. Where this method is employed in liner assembly it is said that 16 minutes will shrink them about 0.006-inch. After the liners have been inserted into the bore room temperature brings them back to normal diameter, in which condition they exert a tremendous pressure on the cylinder walls. The fit is so tight that it has been found necessary to exert three to five thousand pounds pressure to dislodge the liners from the bores of the cylinder blocks.

Equally interesting from an engineering standpoint is the dry ice press which is substantially a hydraulic press employing a pressure of 250 tons on a plunger with a surface of 400 square inches. Carbon dioxide, already liquefied in another press, is fed to the container in the dry ice press. Because the temperature at which this liquid is frozen is 110 degrees below zero Fahr. this container is insulated with phenol-resin sheets in order that transmission of heat from the atmosphere will not lower the efficiency of the freezing operation.

Direct Drive Gains Another Point

ELIMINATION of belts, pulleys and couplings for driving grinding spindles is effected by in-built motor design. This characterization of the trend toward direct-driven units is found in the new spindle, Fig. 5, developed by Ex-Cell-O Aircraft and Tool Corp., Detroit, for its abrasive surface grinder. The rotor of the electric motor is mounted directly on the spindle shaft,

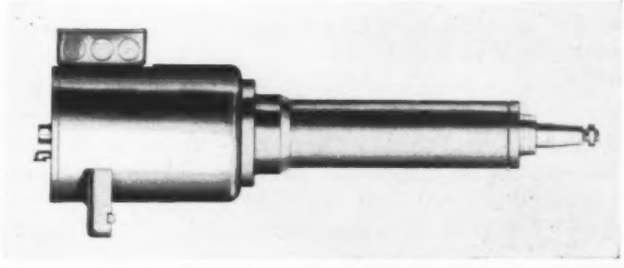
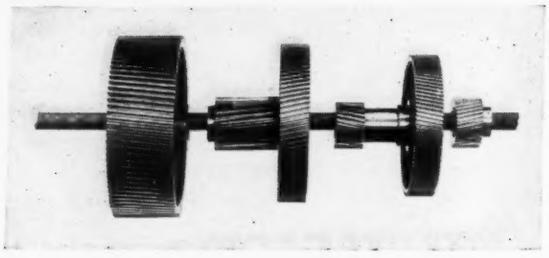


Fig. 5—By incorporating the motor in the grinding machine spindle, compactness is aided considerably

the motor field being mounted in the end opposite the grinding wheel. A one horsepower motor is employed, forming a compact and rigid unit. This development represents an important step in the design of a unit for the elimination of vibration, ability to take heavier cuts and maintain high quality finishes on a wide variety of work.

Deserting Tradition In Special Drive



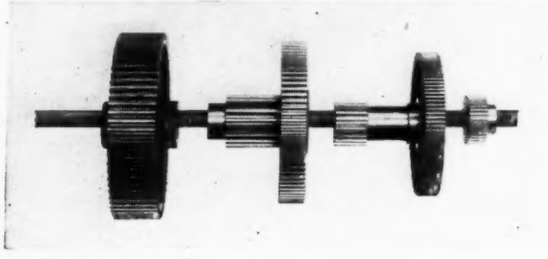


Fig. 1—Gears of the special type helical train, above, and the gears they replace, below

ENGINEERING problems usually are a compromise between the different requirements and must be modified by the available materials, parts and production equipment. Some of the things we desire are not essential, but we think them so because some ancient practice under different circumstances has apparently proved that they are. Changes in materials and new developments in designs, machine tools and processes make a new outlook necessary if we are to produce the best.

The development of modern planer drives is an outstanding example of this need for constant study of changes as they are made in other industries, rather than in the one with which the designer is directly connected.

Helical Gears Maintain Form

As helical and herringbone gears, offset and spiral bevel gears, and hypoid gears became available at reasonable prices through the development of improved gear cutting machinery, they were gradually applied to planers. The first step was to make the pinion on the pulley shaft, and its mating gear, of the herringbone type both for the purpose of reducing noise and in order that the gears should maintain their form throughout their life.

Helical gears are easy to cut and the mating gears can be cut with the same hob, if the hobbing process is employed, and necessarily will have conjugate form. In cutting herringbone gears, however, it is necessary to cut a right-hand helix, then reset the machine and cut a left-hand helix, and it is not always possible with some types of gear cutting machines to have the helix angle exactly the same for both helices. Therefore, some herringbone gears were quite successful while others cut in the same machines were not successful as compared with the best grade of spur gear cut with disk cutters. However, the herringbone gears had the advantage that they maintained their efficiency, while the spur gears, which originally were perfectly satisfactory, eventually wore to the point where they were producing work with objectionable tooth marks.

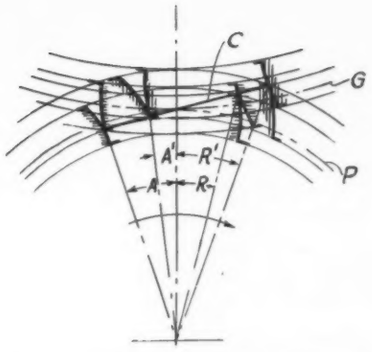
Combination Gear Train Devised

It occurred to the writer that it might be possible to cut a combination herringbone and helical gear train for a planer in which the herringbone gears would have low pitch line speeds while the helical gears operated at higher pitch line speeds. By keeping the helix angle of the helical gears at a low value, say 15 degrees, the end thrust could be reduced to a minimum, and since the planer, unlike the lathe or milling machine, reverses frequently, lubrication of the thrust bearings does not offer a serious problem when the thrust loads are not heavy.

Experience with the Sellers drive indicated that plain thrust bearings would be satisfactory for planer services if the end thrust were reduced to a small fraction of the cutting pressure of the tool. Accordingly, the planer drive shown in Fig. 4 was designed, consisting of a right and left-hand helical rack, a double helical bull gear and a double helical bull pinion, a left-hand helical gear keyed to the central portion of the bull pinion, and a train of helical gears from thence to the pulley shaft, so arranged that the thrust of the pinion on any shaft opposed the thrust of the gear on that shaft. In this manner it was possible to distribute the end thrust of one gear on six thrust bearings, three of which would take the thrust during the cut stroke while the opposite three would take the thrust during the return stroke. Since the direction of the thrust reverses each time the planer reverses, it would be impossible with such low thrust pressure to squeeze the lubricant out.

In Developing

By Forest E. Cardullo
Chief Engineer, G. A. Gray, Co.



A—angle of approach, std. tooth
R—angle of recess, std. tooth
A'—angle of approach, long addendum pinion tooth
R'—angle of recess, long addendum tooth
P and *G*—pitch circles, pinion and gear
C—line of tooth contact
Horizontal sectioning—standard tooth outlines
Vertical sectioning—special tooth outlines

Fig. 3—Angles of approach and recess for standard and long addendum pinions when driving mating gears

The helix *A* in Fig. 4, was made of greater width of face than helix *B* so that the load per inch of tooth would be the same on both parts of the bull gear. Obviously the bull gear tends to push the table toward the operator's side. However, the pressure of the cutting tools usually tends to push the table away from this side, so that the table, when making a cut, usually has two opposite forces acting on it, one coming from the thrust bearings and the other coming from the much greater side pressure of the tools. As a net result the side pressure on the table is reduced.

Can Hob Any Tooth Form

Any form of tooth desired can be hobbed providing the formation is such that no interference results when the teeth mesh with a rack. An involute rack has straight sided teeth inclined in accordance with the pressure angle of the gear system. The larger the pressure angle the lower number of teeth which can be cut without interference. Since pinions having less than 31 teeth must be used, it was deemed desirable to use a high pressure angle, and accordingly a pressure angle of 22½ degrees was settled upon as being most satisfactory. All of the helical gears were cut with this pressure angle, using a standard hob to cut teeth having equal addenda and dedenda. In the case of the bull gear, however, a 22½-degree pressure angle is extremely undesirable because such a pressure angle has a large lifting component which is about 40 per cent of the tool pressure.

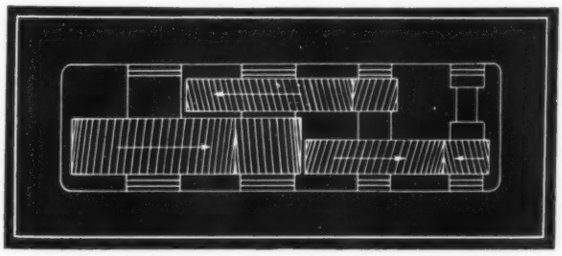


Fig. 2—Bull gear tends to draw rack and table to the operator's side of the machine

Any irregularities in the gearing would cause variations in this lifting component, and the table would tend to move up and down to a much greater degree than if a lower pressure angle were used, thus making the tooth marks much deeper than they would be otherwise. Consequently it first was decided to adhere to a 14½-degree pressure angle in the case of the rack, bull gear and bull pinion, in which case the vertical component tending to lift the table is less than 26 per cent of the tool pressure.

However, the bull pinion necessarily must have a small number of teeth, and interference must be avoided. Without considering the possibility of special tooth forms, the addenda and dedenda of the bull pinion, bull gear and rack were each reduced to 60 per cent of their normal value in order to eliminate interference. A special hob was made which would cut gears with this depth of tooth. This made a planer gear train consisting of a 14½-degree short tooth herringbone rack, bull gear and bull pinion driven by a train of ordinary helical gears of 22½-degree pressure angle. The entire gear train was arranged to run in a bath of oil, insuring adequate lubrication. All gear teeth were generated by straight sided hobs which could be made accurately. The cost of the gear train was increased considerably as two racks, a double bull gear and a double bull pinion were employed. Also there was a slight additional cost due to the thrust bearings which formerly were unnecessary, and the oil bath, which had not been used in previous designs.

Gears Improve With Use

When this planer was put into service, it was found that the tooth marks were still in evidence, that the results obtained were no better than those obtained from carefully cut new spur gearing, and that the only advantage gained was the fact that the gears would not lose efficiency, but rather would improve with use. This planer has been in use for some

twelve years and its performance is steadily improving.

Since the results of this design were rather disappointing, a study was made to see what could be done to improve the form of gear teeth. A mass of data was gathered from other industries which seemed to indicate that teeth with high pressure angles do not run as smoothly as 14½-degree pressure angle gear teeth.

Interesting Disclosures Made

An analysis of the problem also showed that when gears were hobbed by a straight sided hob it was not necessary that the addenda of the mating gear and pinion be equal, and that if there were more than 62 teeth in the mating pair it was possible to cut pinions with small numbers of teeth and without interference by the simple expedient of increasing the addenda of the pinions and correspondingly decreasing the addenda of the gears. This is done by turning the pinions larger and the gears smaller in outside diameter than is customary, and hobbing the teeth to the customary depth. This greatly increases the strength of the pinion teeth without appreciably reducing the strength of the gear teeth. Since the pinion is the driver, it reduces the angle of approach and increases the angle of recess, as shown in Fig. 3. During the angle of approach, friction due to the sliding action of the teeth tends to increase irregularity of action, while during the angle of recess it tends to reduce such irregularity. Accordingly, gear teeth with long addendum drivers run much more smoothly than do gear teeth

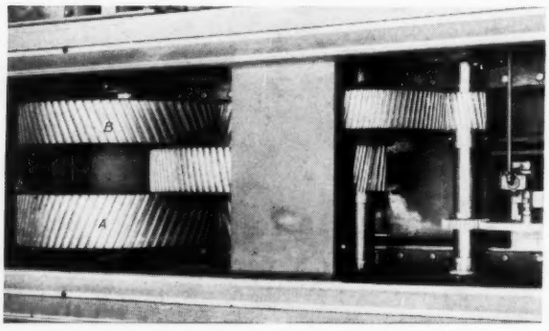


Fig. 4—Load per inch of tooth is equalized on both parts of the bull gear, A and B

where the addenda and dedenda are equal.

Having accepted as satisfactory the idea of end thrust in the gear train, and having found that in the planer such end thrust and side thrust on the table is not objectionable, it was decided to utilize the new knowledge in designing a gear train in which all teeth were to be of 14½-degree pressure angle, and of the full working depth, eliminating interference and increasing the strength of the pinion teeth and the smoothness of action by using long addendum pinion teeth meshing with short addendum gear teeth. Moreover, it was decided to substitute for the expensive double bull gear construction a helical bull gear, in which the helix angle was reduced to about five degrees and the width of the gear made such that there would be complete overlap of the mating teeth in spite of the small helix angle.

It was decided further that since the gear would work better in the angle of recess than in the angle of approach, some method of obtaining a larger angle of recess between the bull gear and rack would be desirable. After some consideration, it was found that this could be done if the bull gear, which can have but one base circle, were made with two pitch circles, the outer pitch circle being the one which was tangent to the pitch circle of the bull pinion while diameter of the inner pitch circle would be determined by the pressure angle and pitch of the rack. The pitch and pressure angle of the rack therefore were suitably reduced, ob-

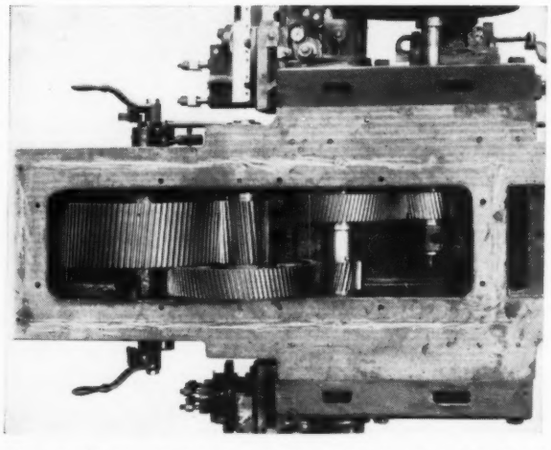


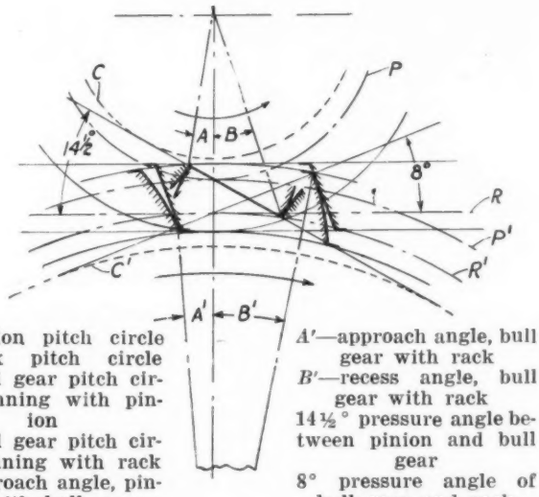
Fig. 5—Upward thrust of the table is about half of its former value in the new design

taining an inner pitch circle for the bull gear as shown greatly exaggerated in Fig. 6.

In order to make the gear faces as wide as possible it was decided to offset the rack so that the edge of the bull gear and rack would be as close as possible to the operator's side of the machine. The reason for choosing this side was that most work is placed for the sake of convenience, not in the center of the table but close to the operator, and this position for the rack puts it more nearly under the work. This left available a wide space for the gear keyed to the hub of the bull pinion besides permitting a widening of the rack and bull gear. As a result of all of these changes the gear train shown in Figs. 2 and 5, resulted. The bull gear, having a right-hand helix, tends to draw the rack and table to the operator's side of the

machine, thus opposing the feeding pressure of the tools in the rail head of the surfacing pressure of the tool in the right-hand side head. The reduction in the pressure angle of the rack reduces the upward thrust against the table to about 55 per cent its former value, or only 14 per cent of the tool pressure, so that even under the most unfavorable conditions the table will ride securely in the ways without any tendency to climb on account of side thrust.

Due to the two pitch circles and resulting slight difference between the helix angle of the bull pinion and the helix angle of the table rack, the bull pinion has a slight tendency to move endways, but no elaborate thrust bearings are necessary to restrain it. The other gears all have their helix angles so arranged that the end thrust of the gear compensates in some degree for the end thrust of the pinion to which it is keyed. As a result, the slight end thrust transmitted to the bull pinion during the cut stroke is distributed on three of the six thrust bearings, one at the end of the bull pinion, one at the end of the intermediate pinion and one at the end of the pulley shaft pinion. With the frequent reversal and the fact that the gears run in a bath of oil, adequate lubrication is secured at all times.



P—pinion pitch circle
R—rack pitch circle
P'—bull gear pitch circle, running with pinion
R'—bull gear pitch circle, running with rack
A—approach angle, pinion with bull gear
B—recess angle, pinion with bull gear
A'—approach angle, bull gear with rack
B'—recess angle, bull gear with rack
14½° pressure angle between pinion and bull gear
8° pressure angle of bull gear and rack
C and *C'*—base circles, pinion and bull gear

Fig. 6—With pinion as driver, angle of approach is reduced and angle of recess is increased on special gear

The use of a special rack, Fig. 7, not standard in either pitch or pressure angle, made possible smoother operation and reduced the tendency to lift the table as the problem was considered in terms of standard engineering practice, the most successful form of design was not possible. As soon as the problem was regarded from a new viewpoint, however, with the idea of developing the best train of gearing for the particular job, success was the reward.

When the planer was built embodying this system of gears, it was found that the gears operated quietly, left no perceptible tooth marks, and that the performance of the machine improved steadily with age. Moreover, the cost of cutting these gears is no greater than the cost of cutting spur gears of equal strength that are less satisfactory in operation.

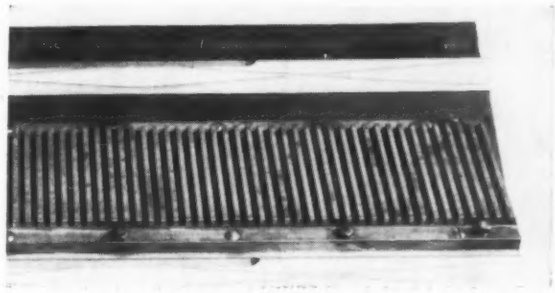


Fig. 7—Smoother operation is afforded by the use of a rack not standard in pitch or pressure angle

It may be noted this gear train is designed especially for its particular service. Such a gear train would not work in a lathe because in an application of that type the axial thrust always would be in the same direction and it would be necessary to provide antifriction thrust bearings to take care of the load. It also may be noted that the gears are not interchangeable. The train will operate satisfactorily only when the pinions drive the gears. The unnecessary characteristics of standard gearing have been discarded in order to secure the characteristics most suitable for this particular job. So long as standard tooth forms were used they would not be satisfactory either in the matter of strength of tooth form or smoothness of action.

Articles on this and allied subjects published in previous issues of MACHINE DESIGN include:

"Hypoid Gearing Affords Interesting Possibilities in Design," Sept., 1929, p. 20.

"General Principles of Toothed Gearing," by John V. Martenis, Feb., 1930, p. 31, April, 1930, p. 34, and July, 1930, p. 34.

"Four-Speed Transmission Units Indicative of New Gears Trends," by Austin M. Wolf, April, 1930, p. 27.

"Proposed Unconventional Tooth Form for Non-Metallic Gears," June, 1930, p. 45.

"Designing Elliptical Gearing by Simple Formulas," by F. B. Fuller, Jan., 1931, p. 25.

"Meeting Modern Conditions in New Gearing Formulas," by George H. Middleton, Aug., 1931, p. 41, Sept., 1931, p. 41.

"Stresses for Heat-Treated Gears," by George H. Middleton, Oct., 1931, p. 55.

"Bringing Gearing Formulas Up to Date," by G. M. Van Voorhis, Nov., 1931, p. 47.

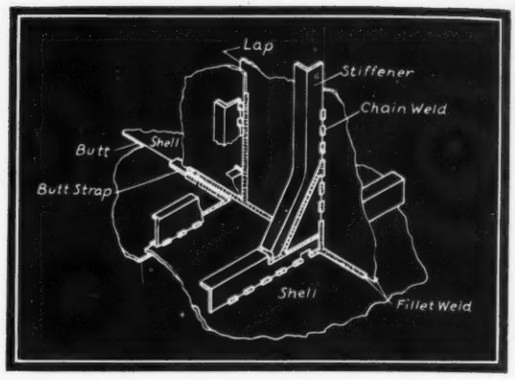
"Modern Gear Efficiency Exceeds Limits Used in Most Designs," by W. H. Himes, Feb., 1932, p. 28, April, 1932, p. 42.

"Determining Horsepower of Gears," by P. R. Guirl, March, 1932, p. 51, also Sept., 1932, p. 41.

"Force Components in Spur Gear Train," by Paul R. Guirl, July, 1932, p. 41.

"Optimum Size of Intermediate Gears," by Frederic B. Fuller, Aug., 1932, p. 40.

"Predicting Worm Gear Efficiency Easily and Accurately," by H. J. Watson, Oct., 1932, p. 31.



Although this welding illustration applies to ships it is equally applicable to designers in other fields

New Ideas Presented in Welding Book

Designing for Arc Welding, *edited by A. F. Davis; published by Lincoln Electric Co., Cleveland; available through* MACHINE DESIGN *for* $2.50 *plus* 15 *cents postage.*

Welding has provided the designer with an effective tool by which he has been able to cope more successfully with the demands for lighter weight, greater strength and compactness. Cost economy also is a factor of importance that aided in promoting its increased use. Some of these possibilities are presented impressively in the new volume comprised of papers entered in the second Lincoln arc welding prize competition (M. D., July).

In the five sections covering machinery, ships buildings, bridges and houses, large containers. piping and fittings, the reader discovers a wealth of information that applies virtually to every type of welded construction. Consider the data on ships for instance; the first chapter is devoted to the paper which was awarded first prize but in it the designer not only of ships but of all steel structures will find valuable information.

All welded structures whether they be for large or small machines have common problems. Details such as those shown in the accompanying illustration, which depicts design and types of welds, have a broad application although they are presented in the section on ships. Each chapter was written by an authority in his particular field.

Television, *by Kenneth A. Hathaway; published by American Technical Society, Chicago; available through* MACHINE DESIGN *for* $2.00 *plus* 15 *cents postage.*

This new book is a practical treatise on the principles upon which the development of television is based. At the beginning is given a brief resume of its history, followed by a review of the elementary principles of light and of optics. Succeeding chapters cover photoelectricity, reproducing devices, facsimile transmission, scanning devices, combining scanning with associated equipment, receiving circuits, motors and electrical scanning.

To those who are undertaking a study of television this book will make a good addition to the library. In view of the interest in the subject it is fitting that the volume be brought to the attention of designers who will play an important part in the industry when it is developed to the commercial stage.

The Nomogram, *H. J. Allcock and J. Reginald Jones; published by Isaac Pitman & Sons, New York; available through* MACHINE DESIGN *for* $3.00 *plus* 15 *cents postage.*

Engineers are realizing the practical utility of the alignment chart and other forms of nomogram. This is shown by the fact that technical literature in all branches of engineering and applied science is presenting more frequently the data for charts representing particular formulas. MACHINE DESIGN has been among those to recognize the value of the nomogram and accordingly published a comprehensive article on the subject in the Feb. issue.

The book to which this review is directed combines a discussion of the general theory with practical directions for the construction and use of all classes of computation charts having scientific or industrial applications. Emphasis has been laid in every case on the details of construction. The reader is aided by examples which are given to illustrate the various methods employed.

Enclosures Improve Machine Appearance, Utility

By S. G. Langley
Chief Engineer, Thomas A. Edison Inc.

MECHANICAL design may be perfect, materials may be the best obtainable, operation may be extremely simple, yet if a machine is not protected from dust and dirt, or if it fails to create a favorable impression, the design as judged by present day standards is not satisfactory. Office machinery has for years been offered the purchaser with little improvement made over the appearance evolved by the purely mechanical design. Such equipment, placed in an office equipped with modern furniture and decorated expertly, was a jarring note in the composite picture.

Take the dictating machine as an example. The outstanding objection to this device as a piece of office equipment has been its slovenly appearance after it has been in use a short time. The skeleton pedestal construction, Fig. 3, exposing cylinders and correspondence folders to dust and dirt, topped by a rubberized cover, presented an incongruous assembly out of harmony in an office. And it is not as if there had been no attempt made to produce a cabinet dictating instrument. It has been tried many times, but the Pro-technic Ediphone, Fig. 2, designed by Thomas A. Edison Inc., Orange, N. J., was the first practical solution for conveniently covering the top plate and speaking tube. Prior efforts resulted in bulky cabinets of clumsy appearance when opened for use.

It was found that by arranging the top plate mechanism to slide a suitable distance from front to back space could be provided to hold the speaking tube within the resulting aperature. A swivel connection, at the point where the speaking tube joins the recorder, allows the tube to swing closely in toward the mechanism providing the compactness at the top of the instrument required for a cover of neat appearance. Removing the speaking tube from the aperture and drawing the mechanism toward the front by means of a hook, which acts as a support for the speaking tube when not in use, provides an aperture at the back that serves as a means for ventilating the compartment in which is the electric motor for operating the machine. Thus no ventilating holes are necessary in the structure. In the design of the new Ediphone, it was realized that complete dustproof protection must be secured without interfering with the facility present in the exposed type. This protection has been secured and

Fig. 1—(Above)—Tapering leg profile overcomes illusion of machine top being larger than the bottom. Fig. 2—(Left) — Redesign harmonizes with present-day office furniture and is well protected

the utility increased with a decided improvement in appearance by the new design.

Having determined the dimension required at the top for proper enclosure of the mechanism, that of the bottom was found to be governed by the spread of the casters, necessary to give stability and freedom from tipping when the instrument is moved around.

Models Were Employed

In developing the shape of the cabinet, many cardboard models were made and studied carefully for the best appearance. As these studies proceeded it was clear that a plain rectangular shape would lend itself best to practical manufacture. It also was found that the corners needed some treatment to correct the illusion of the top being bigger than the bottom. By providing legs tapering in size from the bottom to the top, Fig. 1, with lines melting into the guard for the caster at the bottom and into the top, this illusion was entirely overcome and a better appearance secured.

Fig. 3 — Earlier skeleton pedestal exposed machine parts, cylinders and correspondence folders to dust and dirt

The cabinet body is made from a sheet of No. 20 D. & S. gage auto body stock. It first is sheared to size, and pierced for leg attaching screws at the corners and such other holes as are necessary. Flanges then are formed on what is to be the top and bottom of the cabinet. It next is formed accurately on fixtures into its final shape comprising the back and two sides, the sides being formed in front to take in the two panels, upper and lower, which are spot welded in position to the cabinet body to provide the door opening. The cabinet rests on a base made of No. 18 D. & S. auto body stock which has a molding formed at the outside edge which aids considerably the stiffness and appearance.

The top plate frame attaches to the cabinet with screws through the flanges mentioned previously, making a rigid construction. This frame carries out the idea of the slight taper produced by the shape of the base molding and the legs.

Legs are fabricated from one piece of No. 19 auto body stock and are attached to the cabinet with screws, the heads of which are spot welded to the inside of the legs. Guards or enclosures around the casters are spot welded to the legs. The caster is mounted on a bracket which is carried by the base and which is concealed entirely by the leg. Legs carry no weight or strain of any kind; they are for the purpose of concealing the casters and the corners of the cabinet, providing tapering lines for the reason given in the foregoing. All weight and strain is carried by the frame.

Door Carries Supplies

On the door which swings outward from its piano hinge mounting, are carried the correspondence folders and the wax cylinders. A stop is provided to prevent the door being opened too far.

In designing the cover it was found necessary to give the sides a two-degree taper in order to have them harmonize with the lines of the cabinet. Corner molding on the cover carried out the idea of decreased weight in the general design of the top. The cover is made from No. 20 stock and is arranged to open by means of a piano hinge, remaining in an upright position for use as a tray if desired. It is provided with hooks which engage in catch-plates in the top frame where it is held securely by one clamp screw at the back.

Tools for making the cabinet were designed especially for the purpose. With welding fixtures by which the parts are held in position for the spot welding operations, it is possible to produce the finished cabinet with a high degree of accuracy.

Bolt Standards Revised

REVISION of the American tentative standard for wrench head bolts and nuts and wrench openings has been approved by the American Standards association. Designated standard B18.2-1933, this revision differs from the 1927 edition mainly in that tables for "heavy" bolt heads and nuts have been added to the original smaller "regular" series. American Society of Mechanical Engineers and the Society of Automotive Engineers are sponsors of the project.

Odd Shapes Turned in Lathe

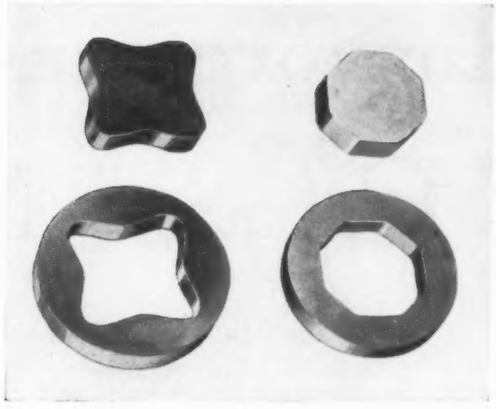


Fig. 1—Noncircular shapes made by device

FAMILIARITY with new production tools and devices and the possibilities they possess in turning out machine parts rapidly and economically should be the aim of every enterprising designer. In MACHINE DESIGN this is being stressed constantly, and in addition every effort is made to present the design details of such devices which show ingenious use of mechanical movements. It is this twofold purpose that occasions the presentation of the centrode device, Fig. 2, which recently was developed by Monarch Machine Tool Co., Sidney, O.

Employed in combination with the company's BB lathe, 23-inch swing or larger, this unit makes possible the turning, boring, and facing of cross-sectional shapes other than round, Fig. 1. Ovals, triangles, squares, hexagons and octagons, and any shape up to 16 sides, either flat, concave or convex can be produced. By using the centrode attachment with an oval chuck, various elongated shapes may be obtained.

The centrode attachment, Fig. 2, is mounted on the crossbridge of the carriage and is positioned by means of the cross feed hand wheel. Power is taken for the device through a telescoping shaft and gear housing mounted on the carriage wing. Drive to the bevel gears *E* is effected through a pair of universal joints *D*. These bevel gears actuate a crankshaft *F* which in turn through connecting rod *G*, reciprocates slide *H*. Through shoe and stud *A*, this reciprocating movement is transmitted to the arms of driven member *I*. The oscillations of *I* are transmitted to swiveling block *K*, creating a forward and backward movement. This block *K*, swiveling on a pin *B* mounted in a feed nut jibbed to *J*, actuates the cross slide *J* on which the compound top block *M* is mounted.

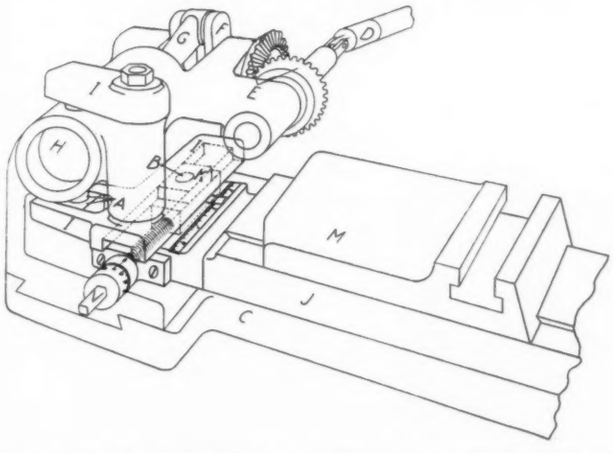


Fig. 2—Centrode attachment is mounted on crossbridge of lathe carriage and positioned by cross-feed handwheel

Length of Throw Is Variable

The entire unit *MJ*, on which the adjusting screw *L* assembly complete is mounted, is dovetailed to casting *C*, and operates backward and forward on this support. The centrode unit, being mounted on an extension of the carriage crossbridge can be adjusted to and from the work by means of the cross feed screw. An adjustment (not shown) is also provided for the top block *M*. By adjusting the feed screw *L* thereby setting the indicator to the graduated scale, it is possible to obtain various lengths of throw for the reason that the actuating arm *I*, being of specific length, increases the arc traveled by block *K* as it is extended toward the end of *I*.

An automatic stroke-changing device is provided whereby the same contour shapes, of changing size such as in a tapered part, can be turned and bored. A simple mathematical formula is used to calculate quickly the correct stroke setting to produce pieces to blueprint dimensions.

Improvements Widen Use of Capacitor Motors

By Allen F. Clark

Associate Editor, Machine Design

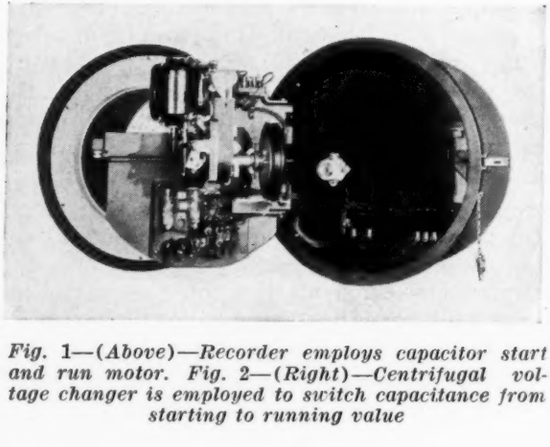
RECENT advances in the design of capacitors, and a rapid increase in the number of motors applied to such domestic loads as household refrigerators, oil burners, fans, etc., has focused attention on the squirrel cage type of single phase motor. The split phase type has been widely used, but its inherent high starting current and consequent line disturbance has limited the use of this motor to sizes of ¼ horsepower and smaller. The use of a capacitor for producing the required phase angle in order to make a self-starting squirrel cage single phase motor, overcomes the disadvantages of the split phase-type.

In the case of integral horsepower sizes the demand for single phase motors is almost entirely in sizes from 1 to 7½ horsepower. Most applications of motors in this range of sizes requires polyphase motors as well as single phase depending on the power line from which the machine is to operate. It is obvious, therefore, that any development of a single phase, squirrel cage-type of motor that can retain the mechanical features and be interchangeable with the same polyphase rating will have many advantages in application.

Two windings, a main and auxiliary, spaced 90 elcctrical degrees apart are used in capacitor motors, making them in reality two-phase induction motors operating on a single phase line. No brushes or commutators are employed. The auxiliary winding is connected in series with the capacitor, the effect of which is to make the current in this circuit leading with respect to that in the main winding circuit. Because of this, it is possible to obtain given torques with much lower current and watts. The efficiency of the motor is high because of the absence of brush and commutator losses, and also because high power factor reduces copper losses. Speed regulation usually is obtained by winding a high slip squirrel cage and obtaining changes in speed by reducing the line voltage. Also, the rotor may be wound for slip ring operation, inserting different amounts of resistance in the rotor circuit for different speeds.

High Capacitance Is Supplied

The single phase capacitor motor is such that during starting and acceleration a fairly high value of capacitance is supplied to give torques equivalent to the polyphase motor. During running, however, this high value of condenser capacity acts as an electrical load on the auxiliary phase and if left in the circuit with motor running continuously would injure its windings. It therefore is necessary, in general purpose capacitor motors, to provide some means for changing the value of the capacitance dur-



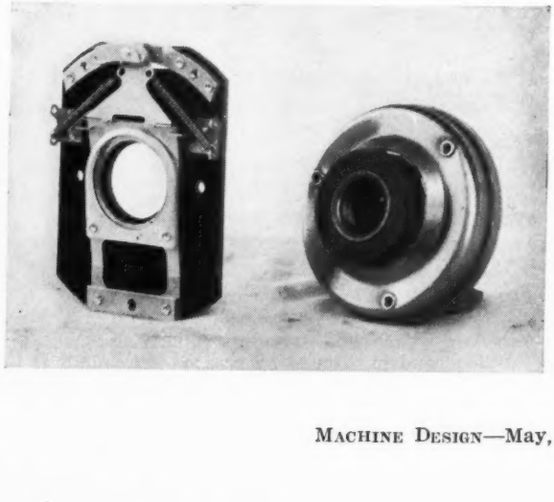


Fig. 1—(Above)—Recorder employs capacitor start and run motor. Fig. 2—(Right)—Centrifugal voltage changer is employed to switch capacitance from starting to running value

ing running to a relatively small value or disconnect the condenser entirely, in which case the running characteristics will be approximately the same as the repulsion start, induction run motor. Devices developed to accomplish the switching or removing of condenser from the circuit during running may be centrifugal switches, Fig. 2, voltage and current operated relays, or magnetic switches controlled by a thermal timer.

Design Generally Not Affected

In general, the design of machine is not affected by the substitution of capacitor motor for other types, an easy substitution as frame sizes and ratings are standard, yet there are a few points which must be considered by the designer when building this recently-stressed type into his machine. Brush rigging can be eliminated where stators and rotors only are applied to the machine, as in Fig. 4. Some types of operation permit the use of open squirrel cage motors but require that motors of the commutator type be either partially or totally enclosed. In applications exposed to explosive atmospheres, it is necessary to mount the condenser outside of the explosive area, although there are motors available, generally in the integral horsepower sizes, which carry the approval of the Underwriter's Laboratories.

Space considerations may operate unfavorably against the use of capacitor motors as many designs have an unfavorable space factor and unless the condenser is mounted separately, the motor takes up more room than other types of fractional horsepower motors. However, this difficulty has been solved effectually in a number of designs by mounting the capacitor at the side, underneath, in the end flange or in some other relation to the motor where it occupies space that normally would not be used. The motor is applied to many machines where it would be relatively difficult and costly to apply a motor with commutator, slip ring or other current switching device.

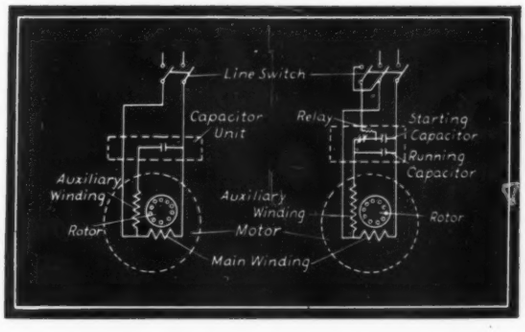


Fig. 3—Elementary diagrams of low torque-capacitor, left, and high torque motor, right, in integral horsepower sizes

The possibility of improved machines comes through the elimination of any mechanical parts formerly needed to change motors from start to run, and through better electrical characteristics which are desirable from the standpoint of the operator as they reduce power costs, and the public service companies as they can furnish power with lower equipment cost. Power factor is improved to a considerable degree.

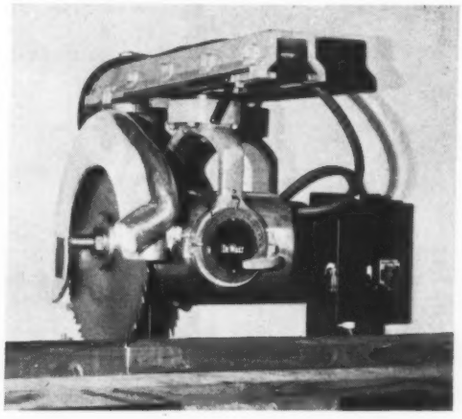


Fig. 4—A squirrel cage rotor is mounted on shaft extension of driven machine

Capacitor motors may be a requirement on machines where especially quiet operation is required; for adjustable speed purposes; where commutators may not be desirable; where stators and rotors only are used; or where freedom from line disturbance is a requirement. This type has all of these qualities in addition to long life and freedom from maintenance obtained by the reduction of moving parts. The motors, further, have high operating characteristics, low starting current to prevent serious flicker of lights, and they develop no radio interference except at start and changeover.

Capabilities Are Standard

So far as capabilities are concerned, the capacitor motor may be considered as parallel to other types of single phase design except for the duties of frequent more severe starting and reversal, plugging and stall torques such as met in valve applications, where they are not as satisfactory as other types since these applications involve the high torque type with increased heating in the auxiliary winding during starting. The motors may be reversed electrically if desired. The squirrel cage rotors and all parts are identical with the polyphase motor, with the exception of the stator windings. The mounting dimensions are interchangeable in

practically all of the popular ratings, and capacitor motors are available as vertical motors, enclosed motors, flange mounted motors, built-in stators and rotors, etc.

Capacitor motors have been classified by most manufacturers in three general groups, although each of these groups are subject to subdivision in order to accommodate the motor to special conditions of service. It is wise to consult the

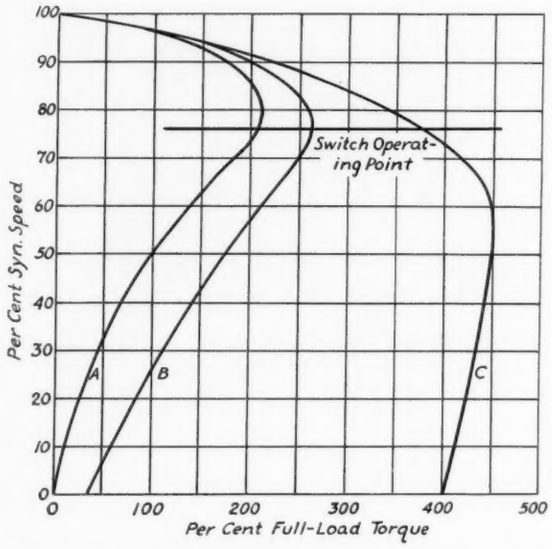


Fig. 5—Typical capacitor motor speed-torque curves

motor manufacturers on all applications not easily classified. The general groupings are:

1—A motor with a single capacitor serving both start and run conditions, where the value of the capacitance does not vary between starting and running periods, Fig. 3. Has high efficiency.

2—A motor of the high torque type, where the value of capacitance changes from the starting to running condition, Fig. 3.

3—A motor of the type where the capacitor is used only during the starting period, the motor continuing to operate under running conditions as a standard single phase induction motor. For low starting torque.

Units in the first group are limited in their application to loads satisfied by low starting torque and are especially suitable for use where the starting torque is less than approximately 50 per cent of the normal running torque. Motors in this group have an outstanding advantage in the field of air moving equipment, Fig. 6, due primarily to the ability of speed control. Construction is simple as no voltage changing device is necessary.

The second style of capacitor motor is one which would be suitable for heavy start torque application, such as a gun type oil burner using a pump and requiring a start torque too heavy for a plain split phase motor with starting current within the NEMA ampere limit on 110 volts. The value of capacitance is changed from the starting to running condition on motors in this grouping. Applications are found principally where a starting torque in excess of 100 per cent of full load torque is required.

Practically no running quietness is sacrificed in the selection of this motor over those in group 1. The motor has an inherently high power factor and efficiency, with higher blocked torque and higher starting efficiencies. The starting current for this type of motor rated at ¼ horsepower would be about 15 amperes at 60 cycles, 110 volts, and the running current 3 amperes.

Motors in group 3 are approximately the equal to those in group 2 with the sacrifice or omission of the running capacitor, which results in a lower full load power factor, as well as a tendency to greater noise and a lower starting efficiency; that is a demand for a slightly

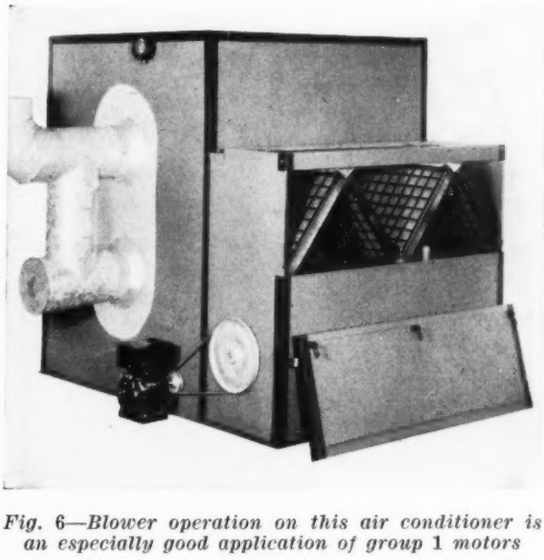


Fig. 6—Blower operation on this air conditioner is an especially good application of group 1 motors

greater blocked current in respect to the blocked torque. Generally speaking, the motors in group 3 are entirely satisfactory for all normal service where extreme quietness is not necessary. Capacitor start, induction run motors do not have a revolving field, consequently they have the pulsations of twice line frequency, tending to produce magnetic noise. They may be compared to the split phase motors with higher starting torque than that available with the resistance or inductive reactance method of splitting the phases. Group 3 motors cannot be considered as truly "capacitor motors" although they are too closely related to this group to be

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Part VI—Flat Surfaces

Considering Design from the Production Standpoint

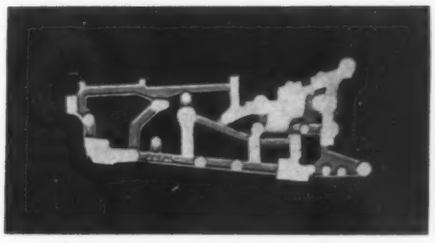


Fig. 1—Grinding facilitates accurate use of castings which have minimum section

By Harold F. Shepherd

ALMOST as we declare that a thing cannot be done or at least cannot be done economically, someone devises a means of doing the job. These facilities, however, are special and apply only to large production. If the demand ceases, or the volume anticipated is not realized, the equipment seldom can be applied to other uses and consequently desirable design changes for improvement or appeal may be retarded due to the expense of creating additional special equipment.

The designing engineer's attitude regarding production difficulties may well be inflexible. When a new product is brought out, the market, not the cost, generally controls the price.

Fig. 2—It is wise to finish no more of a casting surface than is required for best performance

If the capital outlay for machinery is small, it is certain that some profit will be realized regardless of a demand lower than that predicted.

The compressor frame shown in Fig. 3 was designed as shown to meet foundry requirements. The inspection cover pads were sloped to lie parallel to the general outline for the sake of "appearance." This simple decision, dictated by a taste uneducated in matters of production, had far reaching results.

Cutting Time Trebled

It made simultaneous milling or planing of the three surfaces on a three-head machine impossible, approximately trebling the cutting time. It made necessary two extra crane lifts to reset the job with the inevitable indeterminate waits for crane service. It introduced the need of a fixture to tilt the casting to the required angle.

Eventually the required output of these frames exceeded the 24 hour daily capacity of the one large milling machine available to finish them, and the purchase of another had to be considered. The pads then were set square with the base to increase the production, and as a natural expression of the relief from capital expenditure and the lowered cost, the castings were declared better looking than before.

All pads operated upon by one cutter should lie in one plane and run out clearance for the largest cutter that can be employed on the job should be provided to avoid the great time loss of profiling with a small end mill.

Design for milling must include the possibility

of carrying out all the operations possible in one position of the work with the one cutter fixed in each spindle. Design also may dictate the type of cutter that can be employed on the work. The box in Fig. 5 was made as shown for twenty years. On account of the spaced shoulders this job was slabbed with an interlocking two-part cutter working on its periphery. Cutters of this type are subject to selective wear since any one element of the cutter always contacts the same line on the job. Variations in casting or cut-

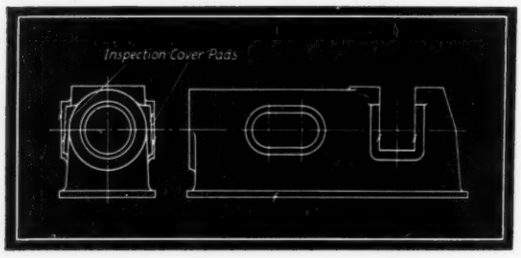


Fig. 3—Simple changes may permit considerable saving in finishing the flat surfaces

ter hardness tend to exaggerate blade wear in certain regions. No matter how true the original cutter, it develops a grooved profile in time and produces ridged work unless frequently reground.

A war time emergency precipitated a demand for these boxes beyond the full time capacity of all the milling machines installed and furthermore no space was available for more machinery where the group was located. An appeal to the design department for relief brought out that flange *a* never had been of any use, since shoulders on the shaft prevented the boxes from drifting inward. It developed further that flange *b* might be eliminated by a slight change which would make the oil seal serve as a keeper. Both flanges were eliminated. It became possible then to use face mills on the job with greatly increased production and improved accuracy.

Face Mill Surface Is Accurate

It often is not appreciated that the surface produced by the face mill is the most accurate possible if the spindle is normal to the ways. Each cutter element describes most of its orbit on the work. Assuming in the nature of things that there must be one high tooth it nevertheless touches every part of the job, the cuts crossing and tending to produce that mat surface which is the ideal of lapping and the imperfectly realized ideal of uniformly spaced islands of contact attempted in scraping. This accuracy cannot be approached by the slab or peripheral mill without end motion.

Happily a job designed for milling is a good planer or shaper job and is adapted equally well to grinding on any type of machine.

Originally the face grinder, while it possessed all the desirable inherent characteristics of the face mill, suffered under the handicap of being unable to relieve the cutting element of chips and wheel waste. It was necessary and still is advisable to design work for these machines with narrow interrupted surfaces between which the wheel might clear itself and avoid glaze and frequent necessity for redressing. Segmental wheels have in a large measure overcome this objection since they have chip clearance between cutting elements much like the face mill.

Might Reveal Imperfections

It is wise in spite of this improvement, however, to finish no more of a surface than is required. It is doubtful if any time is gained on the casting shown in Fig. 2 in interrupting the boring mill cut by breaking up the top plane into a great number of bosses. The advantages are of another sort. Uncovering the whole surface would remove the stronger and denser casting skin. It would expose perhaps quite harmless imperfections which might be characterized as "flaws" by the purchaser.

The machine to be used for finishing flat sur-

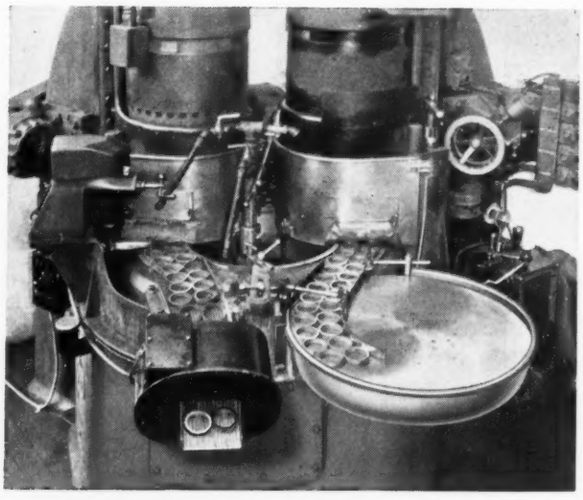


Fig. 4—Disk velocity slightly exceeds that of work table. Work demagnatizer is the black cylinder at left, chuck demagnatizer the unit in center

faces usually is chosen by the production department. It is rare to find the words plane or mill on a drawing. "Grind" however, is necessary because in hard work it involves two operations and in castings it calls for a minimized finish. Grinding permits use of iron casting of the utter minimum section, Fig. 1,

without regard to the chill which makes such work impossible to finish creditably by planing and costly to mill. Consequently it always should be specified for thin work.

In rod and link work, Fig. 6, the velocities of motion at the two ends frequently are not alike and the designer in attempting to use suitable projected areas makes the ends not only of unequal diameter but of different widths. This introduces resetting in slab milling, it makes two operations of straddle milling and requires special provision for grinding on the vertical machine with the magnetic chuck. Almost invariably the two ends can be of the same width.

The straddle milling of little links is always an unduly tedious operation. A new development is stamping the surfaces flat between dies in a crank press. Naturally if the part does

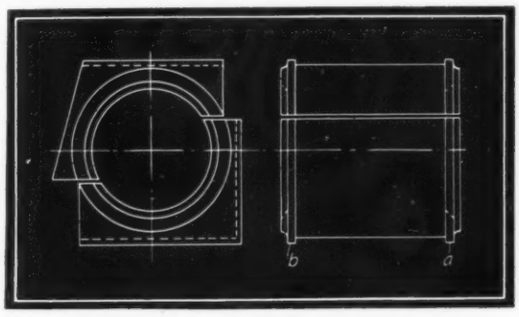


Fig. 5—Design of the part dictates the type of cutter that can be employed

not lie flat on the anvil die before pressing it will not be true by the amount of its elastic recovery after stamping. This, however, may be quite as good or better than a dual operation in a jig. If true drop forgings are used rather than castings, possibly deformed in annealing, the result may be quite accurate and the cost of the operation measured in mills or fraction of mills. This principle deserves extension.

Supporting Means Important

The initiation of accurate flat surfaces of some extent, whether they are to be refined by scraping or by lapping or used as machined, depends upon the means of supporting the work against the pull of gravity and flatness in use depends upon the means of holding down.

For small work not measurably influenced by gravity and not subject to deformation in use, the three-point support principle is being applied to cast or forged work of ferrous metals held by magnetic chucks. Tits of size and span most efficiently gripped by the design of chuck in use are cast on one side of the job. The smooth side is ground with this support, providing almost perfect chuck contact for the next operation.

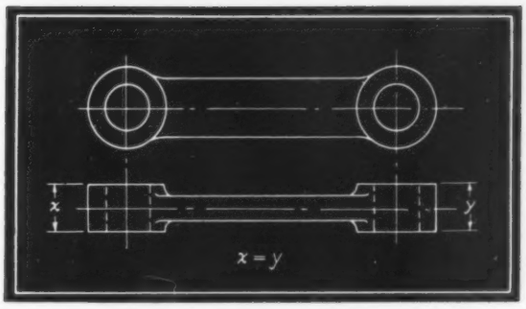


Fig. 6—Two ends of piece used for rod and link work should be made of the same width

If such work has two parallel sides without projections it may be machine lapped between abrasive disks or charged iron plates to almost gage accuracy and at small cost. This process is used considerably for fine piston rings.

Not all surface grinding machines are hooded to permit use of coolant. Wet grinding should be insisted upon, however, for hardened work. Dry grinding unless carried out with extreme caution produces temper checks often crazing the entire surface. These may not be apparent at once nor is the heating evident since the trailing cut of the wheel removes all coloration.

Parallel Sides Not Essential

Parallel sides are not absolutely essential to surface grinding on magnetic chucks. Ingenious fixtures have been devised to hold and magnetize irregular jobs.

Continuous grinding, Fig. 4, also is possible on the surface grinder with magnetic chuck. A demagnetizing element opposes the flux from the chuck at one sector permitting finished work to be deflected off and unfinished work to be conveyed in to take its place. This with automatic sizing is perhaps the only present possibility of fully automatic flat surface finishing.

Ferrous work ground in magnetic chucks should be ordered demagnetized in one of the machines provided for that purpose if the metallic debris of wear is liable to cling to it and result in unnatural or accelerated consumption of size and surface.

Flat surface work of any kind inside of cases and housings is always expensive and usually can be avoided. The old practice of using flanged crankshaft bearing shells for multicylinder engines practically doubled the boring mill time before it was realized that one bearing should be located to receive the thrust, the others merely being clamped in position by the caps. Today facing cuts on bearing seats are studiously avoided.

Blanchard Machine Co., Cambridge, Mass., considerately furnished the photographs used as Figs. 1 and 4 in this article.

MACHINE DESIGN

L. E. JERMY, EDITOR
ALLEN F. CLARK
HAROLD B. VEITH
F. H. BURGESS

Knowledge of Conditions Facilitates Guarantee of Performance

WHETHER or not a manufacturer of machines, equipment or parts should guarantee his product appears on the surface to be an innocent and perhaps an academic question; but it is not as simple as it seems.

A worthwhile guarantee implies that the manufacturer shall have some knowledge of the manner in which his product will be used. Unfortunately this is not always the case, and it is on this point that two schools of thought are in open conflict.

On the one hand is the opinion, usually voiced by the representatives of large companies, that the user of machines knows what he wants, that he should specify the equipment he desires and that the machine manufacturer should supply it according to these specifications.

The other opinion, which we believe will gather strength as time goes on, is that the manufacturer, who presumably knows better than the user the capabilities and limitations of his product, should be permitted to study the user's problem, to prescribe the equipment required to meet that problem and then to furnish it, accompanied by a guarantee.

In the majority of cases the latter policy will prove to be better for both user and seller. It sets up a partial barrier against buying and selling on price alone. It helps the buyer to obtain a better return on his investment. It stimulates the manufacturer to sell performance rather than a machine. In general it points the way to higher standards in design, production, merchandising and use of machines.

• • •

Standardizing Machine Speeds

CONSIDERABLE effort is being expended by an A. S. M. E. committee in formulation of a standard for machine speeds. Obviously such a standard would apply primarily to the speeds of power input shafts and ordinarily should not extend beyond this point, excepting perhaps in the case of certain machine tools having a series of spindle speeds.

While there is much to be said in favor of standardization, it seems likely that this particular standard will meet with more than the usual opposition even though speed standardization already has been adopted widely in Europe. Without due care in investigation and in the selection of speeds, the standard would serve to hinder rather than promote good design. Engineers therefore who may be in position to influence the drawing up of the standard would benefit the profession materially by giving the committee their views on the proposal. Concerted action alone will prevent standardization becoming "retardation."

Carl Gustaf De Laval

Master Designers

Carl Gustaf De Laval

Many early inventors were dissatisfied with the prime movers available for operating the machines they devised, but it remained for Carl Gustaf Patrick De Laval to remedy this defect by developing an improved prime mover. This invention, first designed for operating a centrifugal cream separator which he had developed previously, was the first practical steam turbine. Although based upon the principle of Banca's turbine, Dr. De Laval's machine involved refinements in mechanical concepts that made it an entirely distinct unit.

THE diverging nozzles that made this turbine a success were so unique that patent examiners did not believe the idea was practical and would not issue a patent until after an exhibition at the 1893 World Fair proved the soundness of the system. De Laval's turbine created many design problems which he solved by the introduction of mechanisms that later created entirely new trends in design. His flexible shaft was one of the most original and daring inventions in the field of mechanical science.

REDUCING gears required for the operation of the turbine resulted in the pioneering by De Laval of the present system of helical gears. His contributions in this field have been of far reaching importance. In addition to these achievements, this outstanding engineer, born in Blasenborg, Sweden, in 1845, invented a device for the more perfect distribution of air in bessemer converters, an improved crucible for galvanizing and a boiler of extremely small water space with a single spiral tube.

CUT and try methods were not acceptable to De Laval. This man who after receiving a technical education and starting work, returned for additional training, produced his inventions along entirely scientific lines. His developments were radical changes from the then existing practice and at the same time were highly successful adaptations of scientific principles. During De Laval's lifetime, industry was not yet ready to comprehend and utilize the fruits of his creative genius, and the true value of his inventions was not appreciated fully until after his death in 1913.

PROFESSIONAL VIEWPOINTS

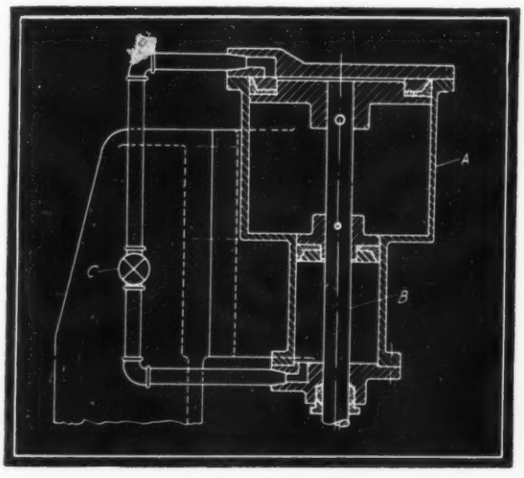
Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments and Questions from Our Readers. Machine Design Welcomes Letters or Solutions to Problems Suitable for Publication

Reduces Air Consumption

To The Editor:

STUFFING boxes for centrifugal pumps are packed with plastic packing in one plant on a special pneumatic press. An outstanding feature of this press which probably will be of interest to other designers is the double air cylinder which imparts a rapid return of the machine ram after the pressing operation. With this design the air consumption is reduced appreciably.



As high pressure is not required to return ram on press, small return cylinder is used

The cylinder indicated at *A* has a large and a small bore with corresponding pistons on the ram *B*. Air is admitted at the top of the large cylinder by a three-way valve *C*. To return the ram, air is admitted by the same valve to the bottom of the small cylinder.

Obtain Maximum Working Pressure

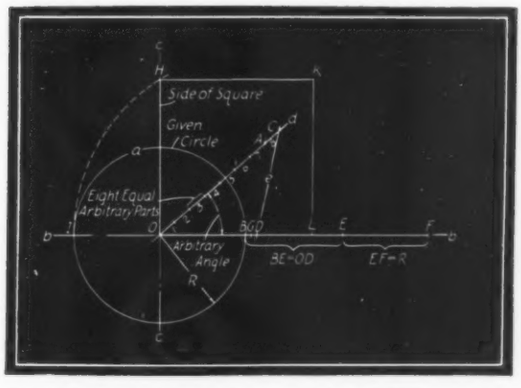
By using a small and a large cylinder the maximum or working pressure is imparted on the working stroke. As the greater pressure is not required to return the ram, the smaller cylinder is sufficient for this duty. For each operation of the machine, the amount of air saved over that used in a cylinder of single design, is the difference in volume of the two cylinders shown. This amounts to a saving in air consumption of about 40 per cent which is highly desirable. In addition to this, a much higher speed of operation is possible due to the rapid return feature.

—E. F. EBERHARD,
Bridgeport, Conn.

Squaring the Circle

To the Editor:

THIS problem, considered a freak in line with the problem of perpetual motion, has had attention by mathematicians through the ages. But unlike perpetual motion which is contrary to all physical laws as known at present, the squaring of the circle does not contradict any laws since it is evident that for any given area *A* a square may be figured by using the value $\sqrt{A}$ as one side. Similarly, for any given square area *A* a circle may be figured of the same area, if we make its radius $R=\sqrt{A}/\pi$.



Simple graphical method solves problem of finding square with same area as given circle

Therefore, it must be possible to select from the infinite number of possible squares and the infinite number of possible circles whose areas

vary from zero to infinity, an infinite number of pairs having exactly the same area. Mathematically, this problem is possible of a solution within any desired degree of accuracy and it remains only to find a simple geometric solution.

Mathematical Solution Is Simple

The circumference of a circle is expressed by $C=2\pi R$, the area, by $A=\pi R^2=\pi\times R\times R=C/2\times R$. If we can, geometrically, construct a straight line equal to one-half the circumference of a given circle and erect at each end a vertical whose lengths equal the radius of the circle we obtain a rectangle, the area of which is $C/2\times R$, or in other words exactly the same as the area of the given circle. To transform this rectangle into a perfect square is a well known and easy step, since the side of the square is the geometric mean between $C/2$ and R.

Since $C/2=\pi R=(2+1.1416)R=2R+1.1416R$, it is evident that if we could find a simple method to represent the value $1.1416R$ our problem would be solved, since all we have to do is to add $2R$ to it (diameter of given circle) in order to obtain one-half of the circumference. It will be found that $8/7=1.1428$, or $2+1.1428=3.1428$, which is about 1/25th of 1 per cent larger than π. This is a degree of accuracy which far exceeds the accuracy of the best draftsman and therefore may be considered ample for any practical application.

The few simple steps necessary to execute this problem geometrically, referring to the drawing, are as follows: (1) Draw the given circle *a* with radius *R*; (2) Draw horizontal axis *b-b*; (3) Draw vertical axis *c-c*; (4) Draw through the origin of circle *a* at an arbitrary angle (about as shown) line *d* and mark off on this line, starting at point *O*, eight equal parts of any desired length:

Graphical Steps Outlined

(5) Through point *C* (end of part 8) draw line *e* parallel to *AB*, *A* being the end of part 7. The intersection of this line with axis *b-b* gives point *D* and it is evident that $OD=8/7R=1.1428R$; (6) Mark off length *OD* from *B* to *E*; (7) Mark off $EF=R$ as shown.

$$OF = OB + BE + EF$$
$$= R + 1.1428R + R = 3.1428R = 1/2C \text{ (approx.)}$$

To find the side of the square having the same area as the circle, use center *G* between points *I* and *F* and describe around *G*, with radius *GI*, the arc *g* to its intersection *H* with axis *c-c*. Distance *HO* is the desired side and *HKLO* the desired square.

From the similarity of right triangles follows:

$$IO/OH = OH/OF \text{ or } OH = \sqrt{IO \times OF}$$

But since:

$$IO = R \text{ and } OF = 1/2C$$

we find:

$$OH^2 = R \times C/2 = \pi R^2 = \text{area of circle}$$

—Wm. A Rosenberger,
Hagerstown, Md.

Materials and Casting Design

To The Editor:

YOUR publication in the April issue of useful suggestions originating with a committee of the American Foundrymen's association, entitled "Nonferrous Materials Affect Casting Design," is of especial interest. It occurs to me that the purpose prompting you to direct attention to the subject of casting design might be aided by pointing out (in no super-critical way) that the title would fit equally well if the head of the article were reversed.

An important fact justifying strong emphasis is that, in an absolutely vital way, casting design affects nonferrous products, as it does those of ferrous materials. It is essential that the design of the casting be developed with knowledge of the behavior of the metal when liquid, when cold, and when at any intermediate stage of temperature that may prevail.

There is no doubt that castings of every variety will have reached a state of better average soundness when designing is done more intelligently than at present. Probably we foundrymen are chiefly responsible for the existing relative state of ignorance because as a class we have not emphasized sufficiently the importance of design as a major controlling factor in developing maximum serviceability of castings. Your magazine has been performing a useful function in this respect.

—R. A. Bull,
Chicago

Machine Develops Tooth Profiles

THE generating method of gear cutting has opened many advantages to the designer; one of the most outstanding and yet least used being the flexibility of design that is permitted. The value of designing gears to their jobs, rather than relying on a certain limited number of forms, is so well established that it needs no long discussion, and the ease with which

specially designed gears may be manufactured without additional time or cost brings up the question as to why this practice is not applied more universally.

A quick and accurate method of drawing any generated tooth shape is made available to the designing engineer by the generated tooth designing machine patented by Herbert S. Ingham, gear research engineer, Sterling Electric Motors Inc., Los Angeles. The drawings not only furnish dimensions of the teeth at any and all points but also show such things as undercut, its extent and by what adjustment it may be eliminated. They show the place at which the addendum teeth become too narrow or pointed, and, most important of all, these drawings furnish the designer with concrete examples upon which to base his judgment in regard to the proportional shapes of two mating teeth, whether they be of conventional unequal addendum design or of a special pressure angle design.

Operation Is Simple

The machine is simple both in its construction and operation. It draws a gear tooth form by generating it on paper similarly to the way in which a gear tooth is generated on a hobbing machine. A small drawing board upon which the paper is fastened is caused to move with a combined rotary and translatory motion beneath a marker which is shaped to represent a tooth space from the basic rack of the tooth system being used. Motion between the paper and the marker represents the motion which takes place between the gear blank and hob. Thus the essentials of the gear hobber can be transferred to the desk and as many trial gear tooth shapes "cut" as desired in a short time. To facilitate its use with hobbing machine, the designing machine has the same adjustments and works from the same "known" quantities as the hobber. The marker, which represents a tooth space from the basic rack or hob, is made considerably larger than the actual pitches used. This produces drawings of an enlarged scale, the actual scale of drawing depending upon the pitch of the gear being represented.

Designers Should Study Part Set-Up Time

A MAJOR problem of the designer of machines is how each piece is going to be manufactured in the shop and how it can be manufactured at the lowest possible production cost, according to Tell Berna, general sales manager, National Acme Co., Cleveland, who spoke before the Job Order Production conference of the American Management association held in Cleveland recently.

Careful Planning Required

The question as to whether jigs and fixtures are justified for setting up a piece is, of course, one that requires careful planning and judgement, and one that depends largely on the quantities. Even in small quantities, however, setting up fixtures frequently are justified. In order to simplify and cheapen the fixture, it may be necessary to change the design. By a skillful design, it may be possible to use the same fixture for several pieces of different size or to use an old fixture. A change in design may make it possible to set up a piece in a gang as in milling, gear cutting or polishing operations. This is a possibility that the designer must bear in mind before the blueprint is finally sent into the shop.

A good deal of care and time in setting up could be eliminated if we avoid close tolerances that are not required by the use of the part. Tolerances are expensive, as we are becoming more and more aware, and expensive tooling and additional operations frequently are called for where, as a matter of fact, they are not necessary from the practical point of view.

On an automatic screw machine, for instance, instead of using a roughing and finishing forming tool which will run for hours without attention, we may have to resort to a roughing tool followed up by a skiving operation, knowing that the skiving tool will not stand up as long and that the tooling will require almost constant attention.

Lugs Are Valuable Aids

On large castings it has long been standard practice to provide lugs or projections for conveniently chucking or mounting the piece when it is being machined. On some pieces, the section may be designed heavier in order to avoid crushing when the piece is chucked for subsequent operations. Lugs may have to be provided by the designer so that the piece can be milled without excessive chucking pressure. These are considerations that assist the shop tremendously in its set-up time problem and they must be considered when making the design.

Lugs, projections and locating points may be of such a nature that they must be removed after the machining operation, but the cost of removing them will be counterbalanced in many cases by the additional speed possible in setting up the piece on the machine.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

IN VIEW of the wide distribution of his mechanical engineers' handbook, Lionel S. Marks needs no introduction to designers. His work as an author, engineer and an educator has carried his name to every part of the land. Recently he was the recipient of one of the 47 Milton awards at Harvard where he is professor of mechanical engineering. The fellowship was presented to Prof. Marks to carry out an investigation of the influence of discharge ducts on the performance of fans.

Born in England, Sept., 1871, educated at King Edward IV school and Mason college, Birmingham, Prof. Marks received his bachelor's degree with high honors at London university in 1892. After two years of research at Cornell in this country and some practical experience, he went to Harvard to give instruction in mechanical engineering, which he has continued to do for 39 years. During the World war Prof. Marks was connected with the bureau of standards and the National Advisory committee on aeronautics.

His scientific output is contained principally in numerous papers presented before the American Society of Mechanical Engineers, and in his books.

BEST known by his connection with the mechanical spring industry, Joseph Kaye Wood has guided the activities of the special A. S. M. E. research committee on springs during the first seven years of its existence. As chairman of this body he initiated the formulation of a general code on the design of mechanical springs. His recent election as president of the newly organized General Springs Corp., New York, therefore is of particular interest to the design profession.

His career covers a varied range of engineering experience. Upon completion of his technical training at Cooper Union Day Technical school he took his first engineering position in the construction of New York's East River tunnels. During the World war he served as a commissioned officer in the engineering branch of the transport service. For five years following the war Mr. Wood was a mechanical engineer in the development department of the Western Electric Co. From there he went to Westinghouse.

After completing work on special problems in connection with equalization systems of electric locomotives he established a consulting practice in New York. During 1930-31 Mr. Wood was consulting engineer to the electric railway presidents' committee and as such took an active part in the analytical phase of the development of an improved electrically propelled car.

MUCH engineering history has been made by the men who saw the possibilities of oxyacetylene for welding and cutting. Design of machinery particularly has shared the tremendous benefits resulting from efforts of such individuals as F. J. King who has worked diligently on the development of the gas industry for the past 24 years. He now is chief engineer, Linde Air Products Co., New York, and recently was elected president of the Compressed Gas Manufacturers' association.

It was in 1909, shortly after graduation from Massachusetts Institute of Technology, that Mr. King became affiliated with his present organization. As junior engineer, he was engaged in the establishment of a nation-wide chain of plants and system of distribution of oxygen, for the manufacture of which the Linde company had been organized two years earlier. During the past four years Mr. King has been actively concerned with process and apparatus development in connection with oxyacetylene cutting and welding.

The recent election of Mr. King as head of the compressed gas organization is further recognition of his contributions to technical progress in the industry. He has been concerned with the affairs of this association since its inception in 1913.

IN his new capacity as manager of engineering for General Electric, Roy C. Muir will have direct charge of the company's designing engineering in the various plants, the works laboratories, and the general engineering laboratory at Schenectady. Fulfillment of the duties of

Leaders in Design, Engineering and Research

LIONEL S. MARKS

JOSEPH K. WOOD

F. J. KING

ROY C. MUIR

this important post will enable him to utilize his wide range of experience in development and application of parts and equipment, gained during his 28 years with the organization.

Mr. Muir was born in Arcadia, Wis. In 1901 he matriculated at the University of Wisconsin, graduated with a bachelor of science degree in electrical engineering in 1905, and entered the student engineering school at General Electric. The first two years he spent on the test. In his second year he was assistant to J. D. Harnden as head of turbine testing, transferring to the central station engineering department in 1907 and spending a year on turbine design.

The first power survey of its kind among industrial users was conducted by Mr. Muir. As a result of extensive work in the application field he was appointed chief commercial engineer of the International General Electric Co. when it was organized on Jan. 1, 1919. He served three years at this post and gained a wide knowledge of engineering practices as carried on in all the large countries of the world. In 1922 he again was promoted, this time to the position of assistant engineer of the industrial engineering department. Leaving this division in May, 1930, Mr. Muir became general assistant to the late Charles E. Eveleth, in charge of general administration of designing engineering departments and works laboratories.

* * *

Charles Piez, chairman of the board of Link-Belt Co., Chicago, and active head of the organization for the past 27 years, is retiring and will move to Washington. His picture and biographical sketch appeared in the Sept., 1929, issue.

* * *

G. L. Fisk, formerly chief engineer of Mesta Machine Co., Pittsburgh, has become identified with the Blaw-Knox Co., Pittsburgh, as assistant to the vice president.

* * *

George Pogue, patentee of several diesel engine improvements, recently became associated with Winton Engine Corp., Cleveland, in charge of industrial sales in the eastern district.

* * *

Allen Abrams, Marathon Paper Mills Co., Rothchild, Wis., was re-elected president of the Technical Association of the Pulp and Paper Industry at the recent annual meeting.

* * *

R. C. Denny recently was appointed chief engineer of the stoker division of Patterson Machine & Foundry Co., East Liverpool, O. Mr. Denny is well known in the engineering profession through his work on stokers and furnaces during more than 15 years with Combustion Engineering Corp., New York, and M. H. Deitrich Co., Chicago.

* * *

John C. Hostetter, since 1930 director of development and research for Corning Glass Works, Corning, N. Y., recently was elected president of the American Ceramic society for the coming year. He has been connected with the Corning company since 1919.

* * *

Clayton N. Ward has been made chief engineer of the firm of Mead, Ward & Hunt, hydraulic consulting engineers, Madison, Wis. Mr. Ward formerly was assistant professor of hydraulic engineering, University of Wisconsin, and is a graduate of the University of Michigan.

* * *

Frank J. Lanahan, president, Fort Pitt Malleable Iron Co., Pittsburgh, has been nominated president of the American Foundrymen's association. Dan M. Avey, editor, *The Foundry*, was named vice president.

* * *

Ivan Ornberg, for the past 18 years assistant chief engineer of the Hupp Motor Car Corp., has resigned to accept a position in his native country, Sweden, with the Swedish automobile manufacturer, A. B. Volvo, Gothenburg.

* * *

H. T. Weis, inventor of the Weis de-slagging apparatus, has joined the Diamond Specialty Corp., Detroit, and will assist in the development and sale of the device.

* * *

J. R. Morrison recently organized the Morrison Engineering Co. with headquarters at 5005 Euclid avenue, Cleveland, to carry on a special machine design service and consulting practice. Mr. Morrison's past experience covers numerous important assignments.

* * *

Dr. Lyman J. Briggs is the new director of the bureau of standards, having been nominated recently by President Roosevelt. Dr. Briggs has been acting director since the death of Dr. George K. Burgess (M. D., Aug.) last July. Biographical sketch of Dr. Briggs appeared in the Dec., 1932, issue.

* * *

O. B. J. Fraser, formerly in charge of the research laboratory of the International Nickel Co., Bayonne, N. J., now is located in the development and research department at the com-

(Concluded on Page 46)

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

Criticism, Comment Sought on Proposed Machine Speed Standard

A PROPOSED American standard for machine speeds was developed recently and now is being distributed to industry for criticism and comment. It is intended to apply generally to speeds of both driving units and driven machines and its adoption will facilitate materially the standardization of speed reduction ratios, pulley, sprocket, gear and sheave diameters and other transmission elements. A national standard has been in use in Germany for some time.

It is proposed that the speed of the driving unit or prime mover shall be considered as the normal full load operating speed of that shaft of the unity by means of which power is delivered. This speed ordinarily is the "rated" speed of the driving unit as specified by the manufacturer.

Speed of the driven machine, due to the possible incorporation of any of the many types of drive available, is liable to a number of interpretations. For the purposes of this standard, therefore, the speed of the driven machine shall be considered as the speed of that shaft, supplied by the manufacturer of the driven machine, through which power is received. Copies of the proposed standard may be obtained from A. S. M. E., 29 West Thirty-ninth street, New York.

* * *

Gearshift Lever Eliminated on New Models of Popular Auto

ELIMINATION of the gearshift lever has been referred to frequently in these columns, and engineers in the automotive industry have viewed the possibilities with enthusiasm. And now Reo's new car is made conspicuous by the absence of the gearshift lever, bringing into reality this development. The automatic transmission has potentialities in that it may thwart the upward trend in engine power. It is pointed out that engine powers and transmission and axle ratios have not been selected primarily from the standpoint of economy in motor car operation. Autos with a wide range of high gear performance have been sought by the motoring public as a way around the annoyance of having to shift gears. Mechanical refinement in this direction opens new avenues to designers for achieving striking improvement in performance.

* * *

Sees Five Billion Dollar Market for Air Conditioning Equipment

EVERY company is interested in new products and new markets. Some have conducted extensive research along this line and are making astounding discoveries. J. J. Donovan, manager of General Electric air conditioning department, for instance, reports that a five billion dollar market for air conditioning equipment exists in the United States. Apparatus for conditioning air will be installed even in small homes as a matter of course, just as electric lighting and modern plumbing now are specified, he believes.

* * *

Court Rules That Government Workers Are Entitled to Patents

LATEST patent controversy centers on government employes but is settled by a sweeping decision of the Supreme Court. The judicial body has ruled that the workers are entitled to patents on inventions from their own ideas even though the work be done on government time. The only modifying condition is that the inventions are not to be the direct outgrowth of work done on particular subjects by direct assignment. This decision is expected to throw open the door of opportunity to many scientists and engineers in government service. At the same time it may lead to congressional action requiring federal employes perfecting inventions on

government time to turn over their inventions to the government.

Commenting upon the decision as "unfortunate" because of contentions by private individuals that inventors with federal laboratory facilities have an unfair advantage, F. S. Holbrook, chairman of a special committee of the bureau of standards said: "Most of our employes voluntarily assign their patent rights to the government, and many dedicate them to the public, refusing to benefit financially from them. It is safe to predict that in the future most of our employes will continue to make this assignment." He pointed out that despite the supreme court's decision the government has a "shop right" in inventions developed under its auspices.

* * *

Scientific Knowledge in Chemistry Increased in Depression

EFFECTS of the depression continue to be a favorite topic. In some cases they are morbid recollections but occasionally something that denotes good comes out. Particularly pertinent is the amount of scientific knowledge that chemistry has put at the disposal of industry. This knowledge has increased greatly during the depression, a summary of the proceedings of the eighty-fifth meeting of the American Chemical society discloses. Chemists are laying foundations for new industries. Dr. John J. Ritter, New York university, reports, for instance, the successful synthesis of camphor from turpentine. Camphor now is imported largely from Japan, and is employed in the manufacture of shatterproof glass, celluloid, explosives, motion picture films and lacquers.

* * *

Sees No Benefit in Diluting Gasoline with Alcohol from Grain

CONSIDERABLE discussion has been aroused by the suggestion that farmers could be benefited financially by blending alcohol with gasoline, this alcohol to be manufactured of course from grain. Objection to the proposal has been raised by Dr. Gustav Egloff, research oil chemist, who declares that the farmer is chasing a mirage which in the end will do more harm than good and will not work to his relief.

His remarks are of interest from a fuels standpoint. If, he said, the states and nation make mandatory the mixing of at least 10 per cent alcohol, this means production of 1,800,000,000 gallons of alcohol yearly. Such an amount of alcohol would mean an increase in the motorists' bill of $90,000,000 a year, based on the farmer receiving 25 cents a bushel for the corn. A car operated with straight gasoline will go 4 per cent farther on one gallon than a car that uses a mixture of 10 per cent alcohol. Dr. Egloff adds that oil refiners can, if they desire, make alcohol from crude petroleum and can make more of it than "the combined output from all the farms in the United States," and also can produce it cheaper than is possible with farm products, except when corn prices are extremely low.

* * *

Refrigerator Manufacturer Reports Large Increase in 1933 Business

CONFIDENCE constitutes one of the most powerful factors in stimulating the present volume of business. Typical of the encouragement that is being expressed is this statement from Westinghouse refrigeration division: "Renewed confidence in the popularly called 'New Deal' is a tangible thing with Westinghouse. The first 1933 quarterly report of the refrigeration division shows an increase in business of more than 100 per cent over the same period in 1932. With production departments working 24 hours a day, officials state that they are preparing for what appears to be the best year of the industry."

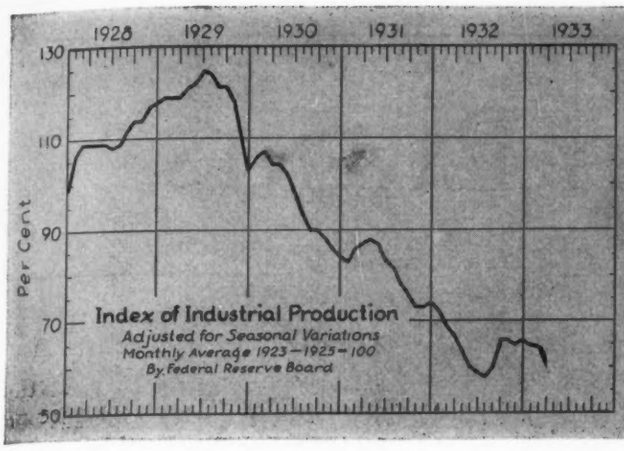
* * *

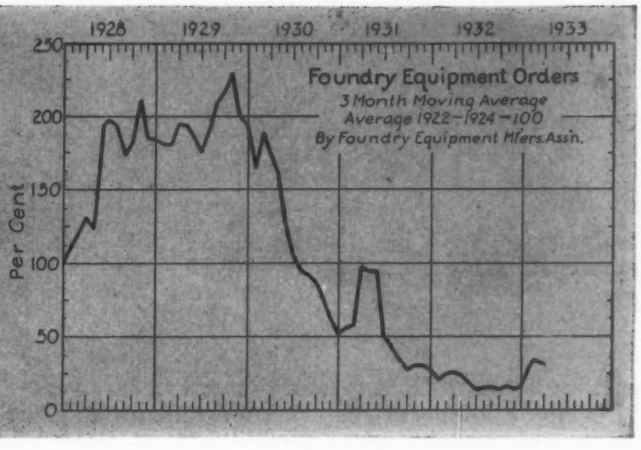
First Printing Press Te Be Among Exhibits at World's Fair

TECHNICAL men over the entire nation are looking forward to the World's Fair which opens at Chicago in June. The exposition promises to hold much of interest to the mechanical profession. There will be on exhibit for instance, the original Gutenberg press which is being brought to this country by special permission of Dr. A. Ruppel, director of the Gutenberg Museum, Mainz, Germany.

In the foundry department type is to be hand cast, just as Gutenberg himself once did it, using the original equipment. Some samples of the master printer's work, among them an original Gutenberg bible, valued at $15,000, will be on display. Cuneo Press, Chicago, which is arranging this exhibit, is erecting working models of its plants to show the progress of printed matter from one department to another.

Progress of the century will be strikingly depicted by the vast outlay of exhibits housed in buildings of unique design. This exposition will stand as an inspiration to designers (M. D., March), the reaction of which no doubt will be reflected in future mechanical equipment.



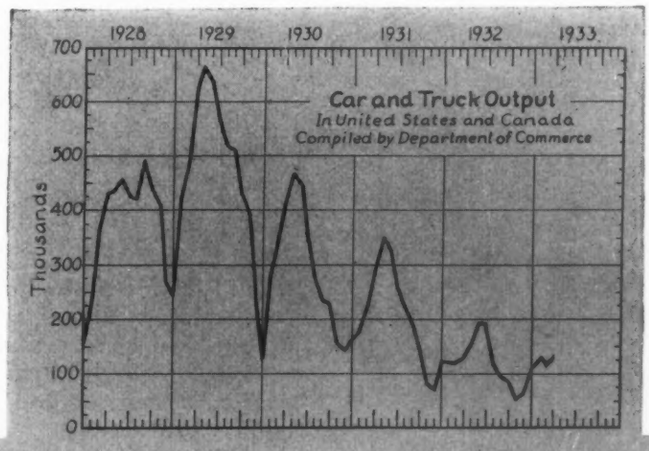


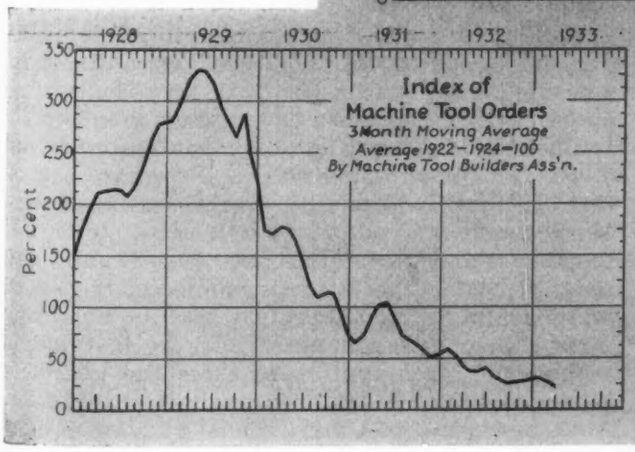
How Is Business?

NEW highs for 1933 have been set with such comparative ease as judged by previous years that they ordinarily have not attracted much attention unless they were startling advances. However, the peak in steel operations reached in April is of such importance to all industry that it is being taken as indication of rapidly increasing business.

This index not only registered an especially encouraging advance but it reversed the trend for the past four years by showing a per cent of operations ahead of that shown in the same week in 1932, the first time the index equaled or exceeded its figure in a corresponding week since 1929. Greater steelmaking operations reflect corresponding increases in related lines such as machinery, automotive, etc.

Another favorable indicator is that showing commodity prices, usually a leader in all upswings. Increased commodity prices increase the buying power of farming and basic industries and give additional support to the pressure bringing about the original increase. The government's policy of controlled inflation has aided this advance but a great deal of the benefit has come from speculators who have anticipated the inflation, and from the reports of a greatly reduced winter wheat crop. Rising prices have brought out some of the accumulated demand, but a great many necessary orders remain to be placed.





NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

SHAFT sealing, a major element in many designs, demands serious consideration. In centrifugal vacuum pumps and elastic fluid compressors for instance this problem of leakage and thrust asserts itself to a high degree. Willis H. Carrier, head of the Carrier Engineering Corp., Newark, N. J., has devised and patented a sealing and thrust balancing means for this type of equipment, which should be of more than ordinary interest to designers. An air compressor of the gear driven type provided with a sealing and thrust balancing device which operates by means of oil pressure is applied to the low speed drive shaft shown in Fig. 1. A sectional elevation is depicted in Fig. 2.

The sealing and thrust balancing device may be housed or enclosed in a casing 22 bolted to the end of gearcase 13 so as to provide a gas tight joint between these parts around shaft opening 21. The chamber of gearcase 13 communicates with the rotor chamber of the compressor by opening 23*a* through which shaft 12

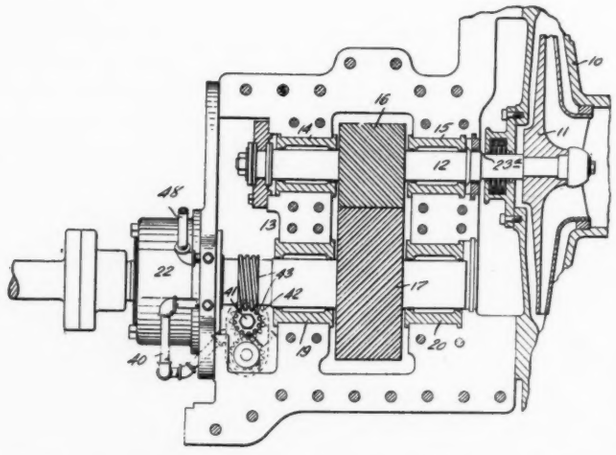


Fig. 1—Sectional plan view of gear-driven centrifugal compressor with liquid type of seal for shaft opening

passes. When the compressor is running, oil used for sealing delivered under pressure by pump 42 to the inner end 35 of the sealing chamber will overcome the pressure of spring 36, moving piston 25 and the combined sealing and thrust members 31—32 outwardly to hold the sealing ring 31 out of contact with an opposing seat 44 formed by a stationary ring at the inner end of the sealing chamber.

Sealing fluid enters the space between sealing ring 31 and its seat 44, passing through

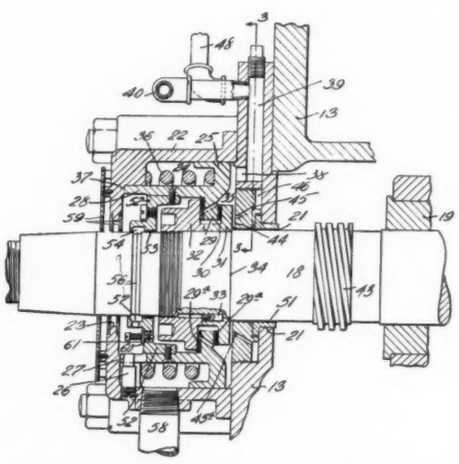


Fig. 2—Oil under pressure moves piston outwardly and enters a space between the ring and the seat

ports 45 in the seat, chamber 46 in the end wall of the sealing compartment, passage 47 and connecting pipe 48 into a reservoir from which the oil can discharge through an overflow pipe to bearings or any of the other parts which might require lubrication.

Fluid pressure and spring 36 acting in opposition on the piston 25, yieldingly resist thrust in opposite directions on shaft 18, but the spring automatically can close the sealing member 31 against seat 44 only when the compressor is shut down and oil pumping stops. Pressure, therefore, on the liquid passing to the sealing chamber will drop and spring 26 will move piston 25, the thrust and sealing member 31—32, and the shaft to which the latter is connected, so as to press sealing ring 31 against seat 44 and thus form a mechanical or valve closure to prevent leakage of air or gas to or from the gearcase 13 or the compressor through shaft opening 21.

During the time that the compressor is not running sealing liquid will be delivered from the reservoir through pipe 48 to grooves 45 and 45*a* in seat 44 and will maintain a film of the sealing liquid between opposing faces of the seat and sealing ring which will assist in maintaining a gas tight joint. The patent is designated No. 1,903,210.

UTILIZATION of centrifugal force is demonstrated by the centrifugal coupling recently designed and patented by James N. Baker. The invention relates to a coupling for connecting driving and driven rotary members where it is necessary to compensate for sudden changes in speed and torque. Typical units in which this occurs include portable power driven hammers, portable power driven wrenches, screw drivers, etc. Black & Decker Mfg. Co., Towson, Md., is assignee of the patent, identified as No. 1,898,806.

A plan view of this type of coupling looking at the side to which the driven mechanism is attached, is shown at left in Fig. 3. Position of the parts represents no load condition, centrifugal force causing arms 27 and 28 to swing outwardly. Assuming that the rotary tendency of the driving member 26 is in a left-hand direction, a load applied to the driven member 25

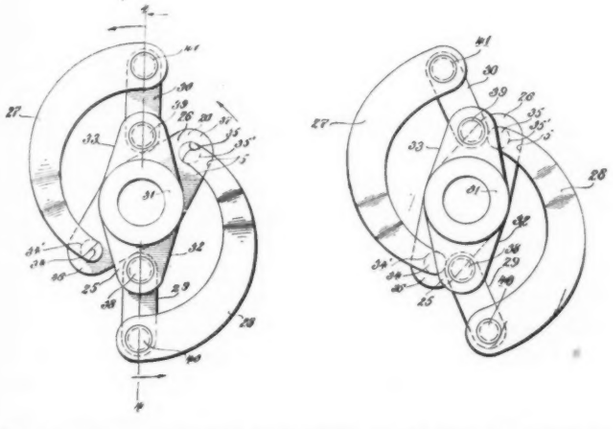


Fig. 3—Action of centrifugal force on linkage compensates for sudden changes in speed and torque in coupling that is particularly adaptable to portable units

would have a tendency to retard rotation of this member in the direction of rotation of driving member 26. This would tend to change the positions of links 29 and 30 to those shown at the right of Fig. 3.

This change of relation of the parts composing the centrifugal coupling due to the delaying of the driven member behind the driving member will continue until the tangential component of the centrifugal force exerted by arms 27 and

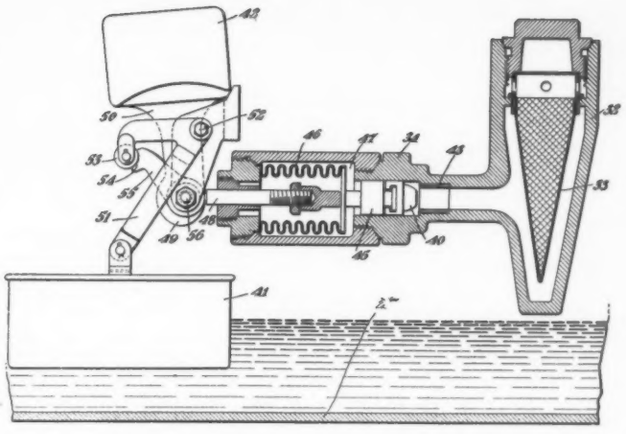


Fig. 4—Bellows holds oil burner control valve open by contraction, and at the same time acts as a seal

28 balances the torque of the load, when the coupling will have reached an equilibrium. Driven member 25 and driving member 26 then will rotate again at uniform speeds, reduction of the torque of the load resulting in a return of the parts toward the no load position shown in the drawing at left in Fig. 3. Weight of the arms is fixed to give the desired centrifugal force selected for best performance at a predetermined speed.

DESIGNING control devices frequently gives the engineer an opportunity to employ such time-honored and familiar parts as bellows (M. D., Jan. and April). In developing an oil burner of the vacuum feed type, Gordon Kinsman makes use of this device in the oil supply control arrangement, Fig. 4. His patent, No. 1,901,456, has been assigned to Caloroil Burner Corp., New York.

In entering the float tank 27 the oil passes through chamber 32, strainer 33 and valve 34. Plunger 40 of the valve nozzle 34 is controlled by a float 41 in tank 27 so that when there is an abundance of oil the float will be raised. This releases weight 42 which will press plunger 40 against valve seat 43, preventing further flow of oil into tank 27. Valve 34 normally is held in open position by means of a contracting and sealing bellows 46 in chamber 47, shown in the center of Fig. 4.

Plunger 48 within the bellows extends outwardly through the valve casing, bearing against cam surface 49 on extension 50 of weight 42. Float 41 is attached to bellcrank lever 51 pivoted at 52 so that a raising of float 41 will release roller 53 from contact with lever 55 attached to and pivoted at 56 with the extension 50. Release of roller 53 permits weight 42 to fall by gravity, the cam surface 49 forcing plunger 48 forward against the action of

bellows 46 to seat valve plunger 40 and shut off the oil supply.

Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

FORGING MACHNE—1,905,620. The combination with the bed frame of a forging machine having a feed gap in one end, a tool carrying heading slide movable toward and from the gap, and gripping dies for receiving stock from the gap and holding it in the path of the slide and tool. Assigned to National Machinery Co., Tiffin, O.

DISPENSING MACHNE—1,905,180. Covered by this patent is a dispensing device comprising a stationary container having a base plate, a spider mounted in the container and means for rotating the spider. Assigned to Horn & Hardart Baking Co., Philadelphia.

VIBRATION DAMPING DEVICE—1,905,723. Bell Telephone Laboratories Inc., New York, is assignee of this invention which covers a vibrating member and a means for receiving and dissipating the excess energy of the member.

SHAFT COUPLING—1,905,431. A coupling for shafts, comprising two hubs, gears on the hubs, torque ring gears co-operating with the hub gears, and gears within a cover co-operating with the torque ring gears. Assigned to John Waldron Corp., New Brunswick, N. J.

PUMP—1,903,721. This invention consists essentially in the provision of a cylinder having valve communication with intake and outlet manifolds. The mechanism is adapted to serve as a pump or rotary engine. Patented by E. R. Munn, Humansville, Mo., and assigned to Munn Corp.

ANTIFRICTION THREAD FOR SHAFTS—1,905,039. This invention embodies a shaft, a nut thereon, the shaft and nut having spiral grooves forming threads. A single row of balls movable in the grooves and a spring at each end bearing against the row of balls are features. Hughes Tool Co., Houston, Texas, is assignee.

Marconi to Head Italian Council

INFLUENCE of research, a subject of interest and importance, is spreading abroad. As an outgrowth of the National Research council the Italian Technical State council is being organized by Premier Mussolini at Rome with the idea of placing at its head Guglielmo Marconi, noted inventor. Purpose of the council, as reported by Senator Marconi, is to recruit competent technical men to make decisions on problems of a scientific or technical character. It will not be empowered to impose its decisions but they will be passed along through ordinary business channels with the endorsement of the council. It is the first governmental move along technocratic lines, it is said, and is designed to aid the manufacture and sale of Italian products.

Men of Machines

(*Concluded from Page* 40)

pany's main offices in New York. He will be in charge of developments in the applications of nickel and its alloys in the oil, gas and coke industries.

* * *

H. W. Cope, formerly assistant director of Engineering of Westinghouse Electric & Mfg. Co., has been made assistant to the vice president, responsible for the co-ordination of certain headquarters engineering departments and district office engineers. He has been identified with the organization continuously since his graduation from Purdue in 1898.

Obituaries

ALFRED F. MASURY, vice president, chief engineer and director of the Mack International Motor Truck Corp., met his death in the recent crash of the ill-fated AKRON. He was aboard the dirigible as the guest of Rear Admiral Moffett, who also went down with the ship. Born Sept. 2, 1882, at Danvers, Mass., Mr. Masury received his education at Brown university, graduating with a degree in mechanical engineering.

* * *

Charles Edward Eveleth, 57, vice president, General Electric Co., died at Schenectady, recently. He had been with the company since his graduation from Worcester Polytechnic institute in 1899, and had been a vice president since April, 1927. As vice president, he first was engaged jointly in the management of the manufacturing department. In 1929 he was transferred to the engineering department in association with Vice President E. W. Allen.

* * *

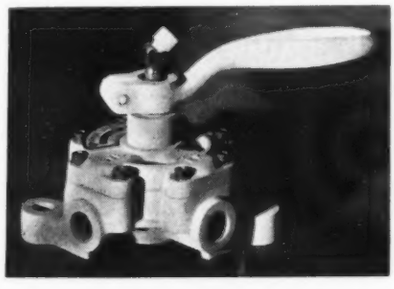
Prof. W. C. Unwin, outstanding as an authority on machine design, hydraulics, and other engineering phases, died recently at the age of 96. In his early career he was instructor in marine engineering at the Royal School of Naval Architecture and later acted as professor of hydraulics and mechanical engineering at the Royal Indian Engineering college. Prof. Unwin taught three generations of British engineers. Among his contributions to engineering literature were two volumes on machine design, part two of which, "Elements of Machine Design," was reviewed in the April, 1932, issue.

NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

New Valve Is of Packless Construction

THE valve disk seats upon the valve bonnet in the new Unitite valve designed by Hanna Engineering Works, 1765 Elston avenue, Chicago, and both the disk and bonnet may be reground without removing the valve body from the pipe line or disturbing pipe connections or valve mountings. Renewals can be made easily by simply removing the socket head cap screws. Between reversals, disks rotate on two eccentric points while in contact with the seats. Circular lines of contact or scoring do not develop; both disk and seat are said to wear uniformly across their full diameter.

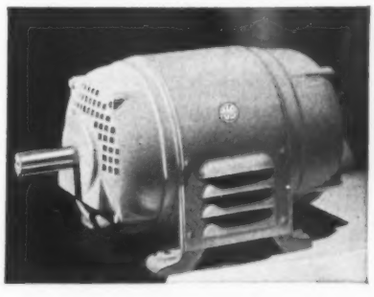


Both disk and bonnet may be reground in new valve without removing the valve from the line

The unit, shown herewith, is a packless valve suitable for air, oil or water at pressures up to 250 pounds per square inch. Both disk and stem are lubricated by an oil well in the stem. The valve is universal in its application and may be used as a straightway, 3-way or 4-way valve. Balanced disk pressure throughout the contact area is attained by the arrangement of seat ports and disk pockets.

Double Enclosure Protects Motors

FOR locations where there are dust, dirt, moisture, acid fumes and elements which more than ordinarily impair a motor's life, U. S. Electrical Mfg. Co., 200 East Slauson avenue, Los Angeles, has designed an efficient Doublenclosed explosion resisting motor. This part, shown herewith, has two enclosing frames with a large fan mounted between the two frames. The inner frame completly encloses the electrical windings, stator, rotor, antifriction bearings and bearing chambers, sealing the parts against intrusion of deteriorating substances. The outer frame completely covers and protects the whole unit.



Motor has a double enclosure which effectually seals it against dust, dirt and moisture

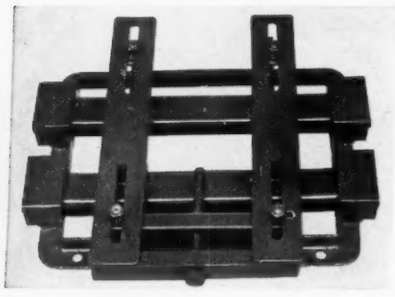
Foreign matter is blown away from the air passages between the inner shell and outer frame while cooling air, passing between the two frames, does not come in contact with the windings or rotating parts and no abrasive substances can touch the active elements of the motor. All cast iron parts are normalized, while the rotor is of die cast aluminum. Bearings are grease packed and sealed within a labyrinth chamber. Windings are protected with asbestos to provide against carbonization.

Designs Sound Insulating Motor Base

SCIENTIFICALLY designed sound-isolating features have been built into the new motor base brought out by General Electric Co., Schenectady, N. Y. Floating members are suspended on specially developed isolating material, enclosed and mounted so as to improve its life and prevent damage from external forces. The motor is mounted as on a standard sliding base, and belt tension and motor alignment are maintained in the ordinary manner.

The bases are installed as a unit, while an adjusting screw moves the motor for belt adjustment. Bases are available suitable for the

following motor ratings and speeds: Polyphase induction motors of 1 to 50 horsepower, 900 revolutions per minute, ¾ horsepower, 1200



Sound isolating features have been built into new motor base which is suitable for motors of a wide range of ratings and speeds

R.P.M., and 1 to 3 horsepower, 1800 R.P.M.; and single phase motors of ½ to 2 horsepower, 900 R.P.M., ½ to 2 horsepower, 1200 R.P.M., and 1 to 5 horsepower, 1800 R.P.M.

Ventilates Enclosed Motors

ONE way ventilation is provided by intake and outlet openings in the lower section of the end brackets on the new line of splash proof motors brought out by the Century Electric Co., St. Louis. Although intended primarily for the typical splash proof installation, the motors are

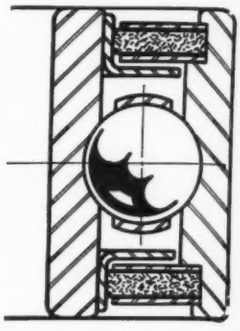
Splash proof motors have one-way ventilation which prevents moisture entering and attacking the motor windings

recommended for outdoor installations where protective buildings or covers are not available. Frame and end brackets are of refined gray iron castings and the bearing bracket is fitted to the frame by long contact sealed fits. Cartridge type grease lubricated ball bearings are used.

Double Seal Bearings Are Announced

COMPLETE protection against foreign matter entering the bearing and loss of lubricant is provided in the double seal bearing, Type TT, offered by Fafnir Bearing Co., New Britain, Conn. In the bearing, shown herewith, steel slingers rotate with the inner ring, while felt washers revolve with the outer ring, thus providing a baffling effect which adds to the seal efficiency. Spring retaining washers on both sides hold the felt washer in place. The felt washer is entirely within the face of the bearing and hence cannot be damaged by external forces. Outer ring faces are finish ground, permitting clamping of the outer ring in the housing. Bore and outside diameter are

Double sealed bearing gives complete protection against foreign matter entering the bearing and possible loss of lubricant by leakage

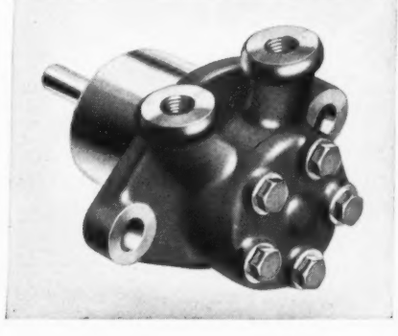


of standard dimensions. The single seal type bearing, Type T, was described on page 54 of the September, 1932, MACHINE DESIGN.

Pump Employs Rolling Action

A TRUE rolling action in the pumping members, which provides a rotary seal in place of the sliding seal found in other pumps, is an advantage of the new Rota-Roll pump developed by Sundstrand Machine Tool Co., Rockford, Ill., for application to oil burners or indus-

Rotor and roller are hydraulically balanced and self emptying, and there is no pulsating load on the two pumping parts



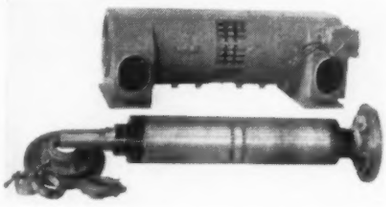
trial installations. The pumping members in the unit consist of a roller and rotor which revolve with each other in a manner similar to a roller and outer race in a roller bearing. These two revolving members do the pumping by means of the rotary seal, the fluid being emptied ahead of the seal through the outlet.

Roller and rotor are hydraulically balanced and self-emptying, and there is no pumping load on the two pumping parts. Pumping capacity

of the pump in 20 gallons per hour at 100-pounds pressure and at a speed of 1800 revolutions per minute.

Unique Motor Is of Small Size

TO MEET the demands of the ever changing conditions of modern industry, Louis Allis Co., Milwaukee, has perfected a unique motor which has 100 horsepower built into a motor less than 12 inches in diameter. This unusual

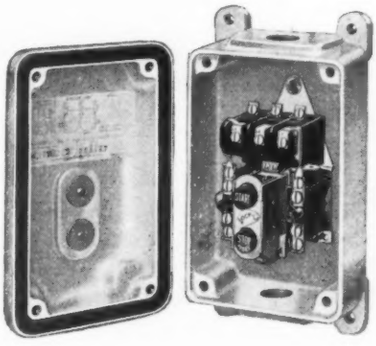


Proportions of the motor can be accommodated to limiting space requirements

type of motor, shown herewith, is said to be ideal for direct mounted grinding wheels, saws, cutterheads, etc. The development of this motor illustrates how the proportions of a motor can be accommodated to limiting space requirements in many applications throughout industry.

Starters Are Splash Proof

SPLASH proof, hand-operated starters for motors up to 3 horsepower, 110 volts, 5 horsepower, 220 volts and 7½ horsepower, 440-550 volts have been added to the standard line



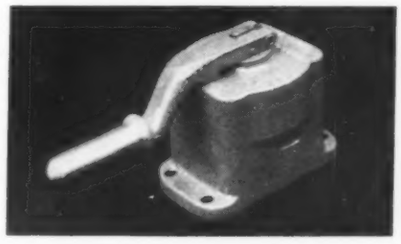
Breakers disconnect the starter after sustained overload in new splash proof units

of starters manufactured by Allen-Bradley Co., 1311 South First street, Milwaukee. The operating mechanism of the units, shown herewith, is identical to the standard bulletin 609 hand-operated starter in which start and stop buttons operate the mechanism without a magnetic coil. Overload breakers disconnect the starter after sustained overload. The cadmium-plated cabinets are provided with rubber cover gaskets. Splash proof push buttons in the cabinet cover actuate the switch and exclude moisture from the switch mechanism.

Air Is Used Twice in Pneumatic Valve

ALL air employed in each cycle of the piston is used twice by the new Sav-Air four-way control valves developed by Q-C Engineering Products, 1310 Maple street, Detroit, and some of the air is used a third time. No air is used from the line for the return movement of the piston, as the bled air from the right to left-hand side performs this operation.

The valve, shown herewith, is of the poppet type, leak proof, and requires no lapping. Bronze



Bronze is used for the valve body while all operating parts are of rustproof material

is used for the valve body, while all operating parts are of rust proof material. As the ports are tapped, the valve may be mounted directly on pipes, or through the use of an adapter plate and a gasket, the unit may be mounted on any plane surface to which the piping is attached.

Bearings Have Textile Base

NONMETALLIC bearings composed of a special textile base impregnated with synthetic resins, molded under high pressures by Gatke

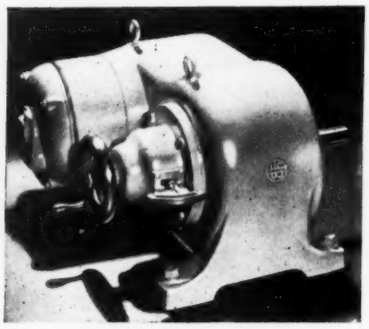
Bearings of nonmetallic material can be molded to dimensions with inserts if desired

Corp., 228 North LaSalle street, Chicago, are now available in many shapes and sizes for general machinery uses. The bearings, shown herewith,

are manufactured from three basically different materials for various services. Hydrotex bearing are recommended wherever bearings run in water or where water is available for lubrication. Lubritex bearings are designed for equipment that is oil lubricated while Grafitex is self-lubricating and especially made for slow moving machinery where dirt and grit are encountered or where lubrication is neglected. The bearings are designed to replace any bearing or bushing. They can be molded to dimensions with inserts if required. No machining is necessary.

Unit Has Infinite Speed Variation

CONSISTING of a simple squirrel cage motor and a variable speed differential which comprises dual disks coupled with the U. S. varibelt, the Varidrive motor announced by U. S. Electrical Mfg. Co., 200 East Slauson avenue, Los Angeles, provides any speed over a wide range at the will of the operator. The differential disks reciprocally expand and contract for higher or lower speeds, transmitting power through the belt to the take-off shaft.

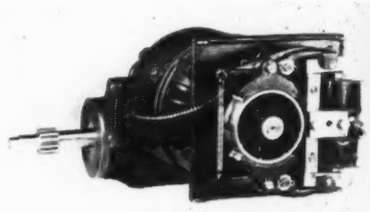


Wide range of speed is possible with motor reduction unit which has built-in control

Speeds may be increased or decreased instantly while the driven machine is in motion. The motor is arranged for local or remote control, a handwheel being mounted on the unit for local control while for remote control a push button station or a handwheel may be installed at the most convenient location for the operator. Automatic remote control also can be furnished.

Magnetic Brakes Control Reducers

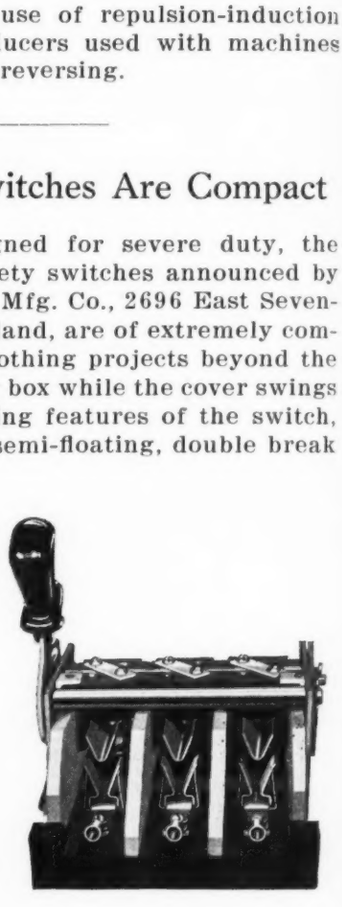
MAGNETIC brakes which provide instantaneous stopping are now available on the line of motorized speed reducers manufactured by Janette Mfg. Co., 556 West Monroe street, Chicago. The brake is of the solenoid type and is mounted on the front end frame of the motor. A steel case encloses the entire brake mechanism. The purpose of the brake is, of course, to make the reducer applicable to those machines which require instantaneous stopping upon the completion of a given piece of work. It also makes possible the use of repulsion-induction motors on speed reducers used with machines which require quick reversing.



Motorized speed reducers are equipped with magnetic brakes which provide instantaneous stopping

Heavy Duty Switches Are Compact

ALTHOUGH designed for severe duty, the new Type A safety switches announced by Electric Controller & Mfg. Co., 2696 East Seventy-ninth street, Cleveland, are of extremely compact construction. Nothing projects beyond the width of the enclosing box while the cover swings vertically. Outstanding features of the switch, shown herewith, are semi-floating, double break V-blades, V-stationary contacts backed up with steel springs, and individual barriers of arc resisting asbestos all mounted on a single base which can be removed easily when desired. Ample space is provided for wiring.



Double break V-blades are employed on new type safety switches which are of especially compact design

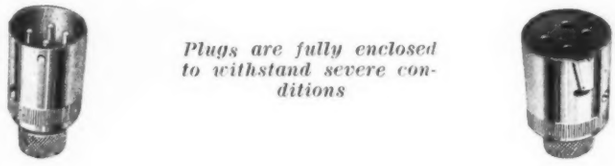
Announces New Stainless Steel

STABILIZATION of 18-8 stainless steels with titanium addition has been announced by subsidiary companies of United States Steel Corp. This development removes the hazard of

intergranular corrosion, a phenomenon which has been a serious factor in installations where heat treatment is impracticable after welding and in cases where these steels are used in applications involving high temperatures. The improved material will be marketed as USS Stabilized 18-8.

Plugs Are Fully Enclosed

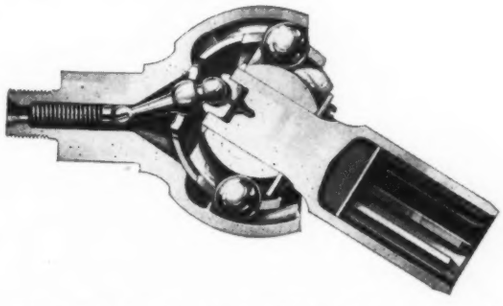
HEAVY duty plugs and receptacles in a new line for use with portable tools, appliances and heating units have been announced by Pyle National Co., 1336 North Kostner avenue, Chicago. These devices are approved for 20 amperes, 250 volts direct current, 460 volts alternating current service and are of the fully enclosed type to withstand severe service conditions. They are capable of making and breaking circuits at these voltages. The cadmium-plated heavy gage drawn steel housings of the units permit rough handling without danger of accident or damage to the equipment. Live contacts cannot be touched under any circumstances of use.



Plugs are fully enclosed to withstand severe conditions

Introduces New Universal Joint

CONSTANT angular velocity is possible with the Rzeppa universal joint manufactured by Gear Grinding Machine Co., Detroit. This machine element, shown herewith, is adaptable to all branches of mechanical construction such as propeller shafts, steering axles, live front and rear axles with independently sprung wheels, marine applications, tractors, locomotives, power winches, tools, etc.

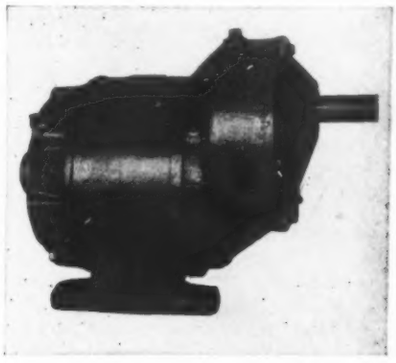


High angularity is possible with universal joint of simple and rugged construction

The three main elements of the units are two driving members separated by a close fitting ball cage, all of which have spherical contact surfaces. They are assembled into a concentric arrangement to form a self-contained unit. The high angle joint is capable of 37½ degrees angular displacement while the low angle joint is designed for 15 degrees. Both types are arranged for heavy oil lubricant and are equipped with oil tight covers.

Gearmotors Designed for Low Speeds

SIMPLE and compact units for low operating speeds are made available by the new line of type S gearmotors offered by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. This unit is only slightly longer overall than a motor of the same rating. Designed for drives from ½ to 75 horsepower and for 1550 to 232 revolutions per minute, this drive may be connected direct to the driven equipment or connected by means of V-belts, chains or flat belts. Fourteen reductions of ratios from 1.12:1 to 5:1 are available for each motor speed and horsepower. Helical gears fully enclosed and running in a continuous oil bath are used.



Gearmotor unit is only slightly longer overall than a motor of the same rating. Helical gears are employed

Synchronous Motor Controls Improved

ALL standard lines of synchronous motor control manufactured by General Electric Co., Schenectady, N. Y., have been superseded by new lines incorporating new features. Included in this control equipment are relays for automatically applying and removing field excitation and for protecting the stator and amortisseur windings under all operating conditions.

For automatically applying field excitation when the motor reaches a predetermined speed

ALLEN

TRI-MARKT

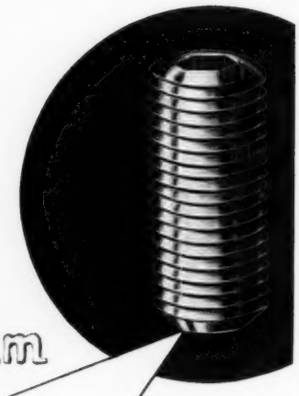
TRADE MARK

HOLLOW SCREWS

of

Chrome-

Mo-lyb-den-um



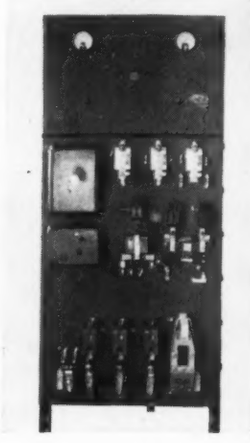
There never was a better time to standard-equip with "ALLENS" — try some samples

NEW DESIGNS on the board, new models awaiting production, unrushed operations on the floor:—all favorable factors to *changing* to ALLENS. One more improvement to go along with those you've made in your product. . . . It's a change your customers will recognize *for the better;* most of them use Allens themselves and may wonder a bit if you shouldn't. . . . In your specifications, Allen-made screws DO add to the buyer's acceptance. In your machines they give new immunity to breakdowns. *Try some samples!*

THE ALLEN MFG. COMPANY

HARTFORD, CONN. U. S. A.

near synchronism, a new relay known as the slip-frequency field application relay is provided. The coil of this relay is connected across a section of the field discharge resistor with a half wave copper oxide rectifier in series with it. During the starting period, induced field current of



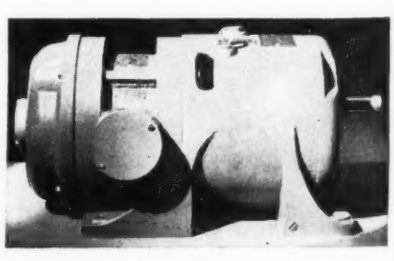
Relay has a short time delay drop-out which holds the contacts open during the period of acceleration

slip frequency flows through the discharge resistor so that half waves of slip frequency current flow through the relay coil causing the relay to pick up and open its normally closed contacts.

This relay has a short time delay drop-out which holds the contacts open during the period of acceleration. When the motor reaches a predetermined speed near synchronism, the time interval between half waves of current is sufficient to allow the relay to drop out and apply field. By a simple adjustment of the relay its time setting can be varied so that it will apply field at any predetermined speed from 92 to 99 per cent of synchronous speed.

Employs Cartridge-Type Gear Unit

GEARMOTORS in sizes rated ¾ horsepower and up are being offered by Reliance Electric & Engineering Co., 1042 Ivanhoe road, Cleveland. These drives combine motor and speed reducer into one compact and fully protected unit. A cartridge-type gear unit carries all gears



A cartridge-type gear unit carries all gears and bearings except the high speed pinion and its bearing

Don't gamble with motors!

The selection of the right type of motor is a task which should be delegated to the manufacturer, jobber or dealer specializing in motors. When selecting motors, Wagner recommends the consultation of authorities on that subject.

Blind chance has no place in motor selection. The motor must be carefully selected to meet the requirements of the machine or job. A misfit is costly. Over-motoring to obtain the required starting torque, or applying a low-slip motor where a high-slip motor should be used, are some of the misapplications made by motor buyers.

The selection of the right type of motor for any given application involves a thoro knowledge of horsepower, speed, current, torque, power transmission, voltage-reducing devices, atmospheric conditions, rules and regulations established by power companies and insurance companies, and even laws enacted by local governments. Thus there are a multitude of factors regarding which the average motor buyer cannot keep himself informed.

Fitting the right motor to the job is *not* a problem of designing and building a *special* motor, but it is one of selecting a *standard* design of motor which is qualified to give the best account of itself. The Wagner line is already sufficiently varied to make special designing unnecessary except in very exceptional and rare occasions. Wagner has in production and in stock a wide range of types and ratings in general demand, so that Wagner customers may obtain the correct motor for the job without delay and unreasonable expense.

Incidentally, the wide range of types and ratings of motors manufactured by Wagner (25,000 type-hp-rpm combinations) is an assurance to motor buyers that Wagner recommendations are made without prejudice, and that at no time will the wrong type of motor be supplied. The squirrel-cage line alone consists of seven electrical types, each type further diversified to meet an almost unlimited variation of applications.

Before you purchase another motor, read the four Wagner bulletins listed in the coupon. Don't gamble with motors!

Wagner Electric

MOTORS
TRANSFORMERS
FANS
BRAKES

Wagner Electric Corporation,
6400 Plymouth Ave., St. Louis, Mo.

Please send bulletins indicated.

- ☐ No. 167 on fractional-hp. motors
- ☐ No. 174 on squirrel-cage motors
- ☐ No. 169 on slip-ring motors
- ☐ No. 176 on Fynn-Weichsel synchronous motors

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ACTUAL "PROBLEMS" IN TRANSMISSION

How would you solve them?

No. 2 • • • • •

A Screw Driving Machine

A motor driven screw driver was planned which would provide a freedom of manipulation not possible with the similar purpose rigid machine that had already been developed. Operating speed of bit was set at 1260 r.p.m. Machine was to be capable of setting up from 8,000 to 12,000 screws a day. The same patented clutch used in the rigid machine was to be incorporated in the new machine. This clutch, when a screw is driven to the desired tightness, permits the bit to remain stationary while the machine continues to run.

The problem was to find an element of transmission which would provide the necessary flexibility and at the same time be capable of standing up under the continual succession of shocks imposed by the on-and-off action of the load.

How this problem, and others equally interesting, were solved in a simple and thoroughly successful manner by the use of flexible shafts, is told in detail in the FLEXIBLE SHAFT APPLICATIONS "Problems and Solutions" book. Your request, on your business letterhead, will bring you a copy—free. Write for it—today.

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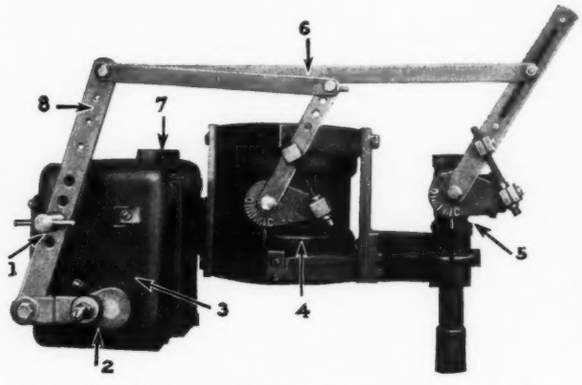
INDUSTRIAL DIVISION
154 West 42nd St. New York, N. Y.

and bearings except the high speed pinion and bearing. The cartridge can be removed without disturbing the alignment of any gears or bearings. A simple train of helical gears is employed.

The ratio of any unit can be changed by the user by simply changing the high speed pinion and gear. Rotating the cartridge gear unit provides 4 to 8 positions of the output shaft. A solid support is provided by feet cast integral with the gear housing. The units can be supplied for a wide range of ratios with both alternating and direct current motors of various types.

Controller Operates Two Valves

TO MEET the demand for a sturdy controller of the two-position type to operate one or more valves as a unit, Automatic Temperature Control Co. Inc., Philadelphia, has designed a new unit known as Type 2, which has sufficient power to handle an air valve up to 4-inch in combination with a ½-inch fuel oil valve or to handle two valves up to 4-inch as a unit on low pressure gas and air.



Controller is designed to operate one or more valves as a unit and can be adjusted easily

Maximum settings for both fuel and air valves can be obtained by adjusting the connecting links 6 where attached to the valve levers, and where attached to the main operating lever 8. With the valves adjusted for desired combustion, the fuel-air ratio is maintained throughout controller stroke. Both valves are moved simultaneously and in unison.

A feature of the controller is the ability to remove the fulcrum stud 1 quickly, thus permitting the attendent to move the main operating lever 8 with attached valves to any desired position manually. This feature is a convenience when starting up a furnace and it also eliminates the expense of by-pass piping and valves for the air line.

THERE IS COMPENSATION IN CONFIDENCE

When you install bearings with the proved ability of Hyatts, you dissipate your bearing problems once and for all. You get all the performance expected. Because the Hyattway is the right way.

From raw steel to finished bearing, Hyatts follow a strict course. More strict, perhaps, than is necessary, but resulting reserves of dependability, endurance, efficiency and economy are thus assured. By definite control of design, production, and inspection, Hyatt bearings are kept constant in quality.

Many performance advantages follow. Hyatts stand up under heavy load or extreme service. They prolong as they protect equipment life. They cut down on repairs, replacements, attention.

Besides—the savings Hyatts bring about enable you to produce a better product at lower cost and higher profit. This, in turn, more than makes up for your original investment in Hyatt Roller Bearings.

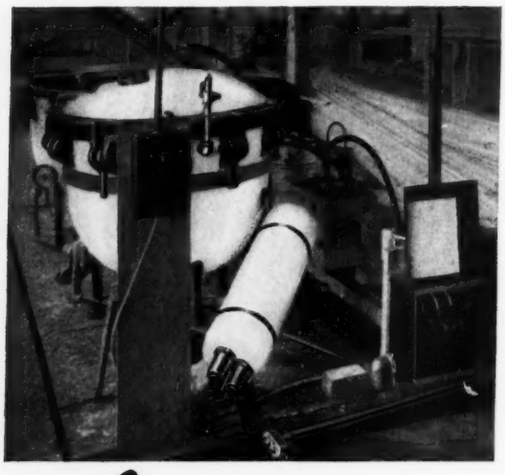
If this alone is not sufficient compensation, remember that to thousands of users "Hyatt Equipped" means a quality product. Hyatt Roller Bearing Company, Newark, Detroit, Chicago, Pittsburgh, Oakland.

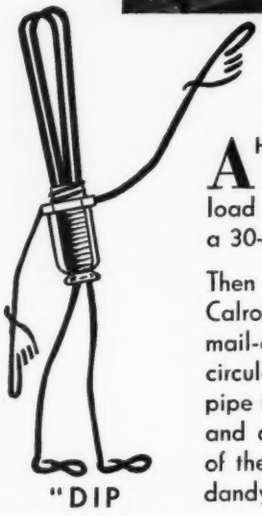
HYATT

ROLLER BEARINGS

PRODUCT OF GENERAL MOTORS

"Dip" heats this dye kettle and saves $6 a day





A HOOKED-RUG manufacturer used to run his steam boiler at reduced load in the summer months just to heat a 30-gal. dye kettle.

Then he read about "Dip," the G-E Calrod liquid-heating unit, in his G-E mail-order catalog. He built a simple circulation heater out of ordinary iron-pipe fittings, using three 5-kw. "Dips," and connected it to the steam jacket of the kettle. Perfect operation and a dandy saving!

"Dip," "Spot," "Strip" and dozens of other midget electric heating units in the G-E Calrod family are described and priced in a convenient mail-order catalog. Write your power company or General Electric Company, Schenectady, N. Y., for a copy.

571-6

GENERAL ELECTRIC

Kindly mail me a free copy of the General Electric mail-order catalog, GEA-1520 on small electric heating units:

Name.....

Firm.....

Street.....

City.....

Improvements Widen Use of Capacitor Motors

(*Concluded from Page* 28)

ignored in a discussion of this type. They should be recognized as "capacitance start split phase motors."

Current used for the motors in group 3 is about 25 to 30 per cent higher than that used by capacitor run motors, that is about 4 amperes for the ¼ horsepower motor at 110 volts, 60 cycles. From a mechanical standpoint, motors in this group are identical with those in group 2 and more complex than those in group 1, as motors in group 1, are free from all electrical contacts and thus are the simplest.

Curves Indicate Properties

Characteristic curves of these motors are shown in Fig. 5. Curve *A* indicates the speed torque characteristics of the main winding, that of a standard single phase induction motor. If a capacitor is to be used only during the starting period, as for group 3, the main winding with the auxiliary winding can be designed to give curve *C*. When the speed of the motor has reached the point where the switch which operates the auxiliary winding is opened, the motor then operates on the upper portion of curve *A*. In those cases where lower starting torque is satisfactory, group 1, the single value capacitor motor with a speed torque curve such as *B* is employed. If a two value capacitor motor is used, group 2, it has a speed torque curve which is a combination of curves *B* and *C*. For the starting period the value of capacitance is the same as for the capacitor start motor, and the speed torque curve is the lower portion of curve *C*. When the switch operates, instead of opening the auxiliary circuit it transfers the connections so as to reduce the capacitance to the proper value for the running condition and the motor continues to run under normal operation in accordance with the upper portion of curve *B*.

For assistance in the collection of material for this article and for the illustrations used, MACHINE DESIGN is indebted to: Bodine Electric Co., Emerson Electric Mfg. Co.,, Fairbanks, Morse & Co., General Electric Co., Ideal Electric & Mfg. Co., Leland Electric Co., Ohio Electric Mfg. Co., Robbins & Myers Sales Inc., and Westinghouse Electric & Mfg. Co. Leeds and Northrup Co. considerately supplied the illustration for Fig. 1 and Fox Furnace Co., that used as Fig. 6.

A list of articles on this and allied subjects published in previous issues of MACHINE DESIGN is given at the end of the article "Motor Performance Is Improved by Proper Mounting," on page 26 of the April, 1933, issue.

Sweet Adeline

(with variations)

Everything goes along as smoothly as Sweet Adeline for a designer, until a piece of equipment begins to register too many breakdowns at vital times in the hands of his customers' workmen. Then come the variations! And how they come!

The increasing number of designers who include Alemite High Pressure Lubrication systems as standard equipment in their designs is gratifying to Alemite, the designers and their customers. In fact, we all thank one another.

There is also an increasing number of designers who definitely specify the types of Alemite Industrial Lubricants which must be used on their equipment. Not just any industrial lubricant — Genuine Alemite!

And that is smart business, too. For Alemite Lubricants are produced for every varying type of industrial need. They STAY PUT! They do their job! They are SAFE and they are RIGHT! Write for complete information.

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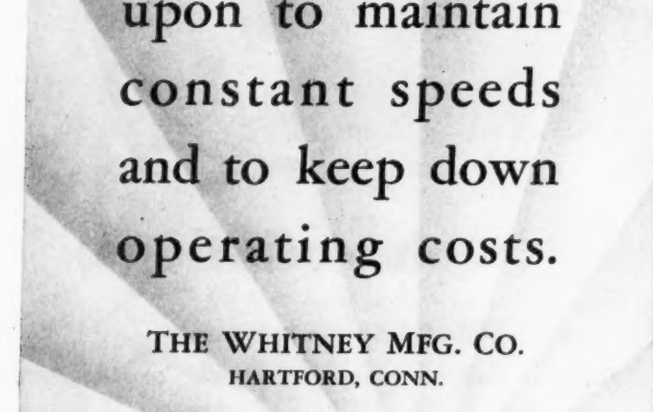


ALUMINUM—"Combating Chemical Corrosion with Alcoa Aluminum," is the title of a new booklet being distributed by Aluminum Co. of America, Pittsburgh. The booklet gives the characteristics of aluminum, its resistance to corrosion, and application of the material in the design of chemical equipment.

CAST PARTS—Climax Molybdenum Co., New York, is issuing a 1933 supplement on "Molybdenum in Cast Iron." The booklet includes additional engineering material on the uses of molybdenum in gray iron, white iron and malleable iron.

COMPOSITION MATERIALS—Bakelite laminated materials and their applications are covered in an attractive booklet of Bakelite Corp., New York. The booklet discusses the manufacture of the material, its properties, uses, laminated gears and directions for working, and includes color plates illustrating the color range and decorative effects available with the material.

CONTROLS (ELECTRICAL)—Heavy duty safety switches of compact design are covered by recent folders of Electric Controller & Mfg. Co., Cleveland.

CONTROLS (ELECTRICAL)—Mercury switches including the Mercrelay, a new type of mercury circuit controller, are described in a bulletin of General Wire & Switch Co., Providence, R. I. The new switch is operated by a slight mechanical motion and the spark is entirely enclosed.

CONTROLLERS—Automatic Temperature Control Co. Inc., Philadelphia, has issued leaflet M-26 on its new motor-operated controller of the two-position type which operates one or more valves as a unit.

DRIVES—Reliance Electric & Engineering Co., Cleveland, has prepared bulletin 400 on its line of gearmotors for alternating and direct current service. The bulletin gives complete details of the construction.

DRIVES—U. S. Electrical Mfg. Co., Los Angeles, has issued a bulletin on its Varidrive motor. This unit consists of a simple squirrel cage motor and a variable speed differential which comprises dual disks coupled with a U. S. variabelt. An infinite variation in speeds is afforded by the unit.

MOTORS—Splash proof motors, with baffles in the air ducts which remove all spray from the air entering the motor, are covered in a new publication of Ideal Electric & Mfg. Co., Mansfield, O.

MOTORS—The first issue of *The Louis Allis Messenger*, published by Louis Allis Co., Milwaukee, contains considerable information on the company's splash proof and other motors and a table giving approximate full load current in amperes of both alternating and direct current motors.

MOTORS—U. S. Electrical Mfg. Co., Los Angeles, is distributing an attractive bulletin on its line of Double-enclosed explosion resisting motors. The motor has two

enclosing frames with a fan mounted between the two frames.

PLUGS (ELECTRICAL)—Pyle-National Co., Chicago, is distributing a folder on its new line of plugs and receptacles for small portable electrical equipment.

PUMPS—Sundstrand Machine Tool Co., Rockford, Ill., has prepared a folder on its new line of Rota-Roll pumps for oil burners and industrial applications. The design includes revolving impellers at slower speeds although speed of drive shaft is the same as in other pumps.

VALVES—Hanna Engineering Works, Chicago, has prepared a bulletin on its new Unitite valves for use with air, oil or water. This is a packless valve with a simple arrangement for the lubrication of moving parts.

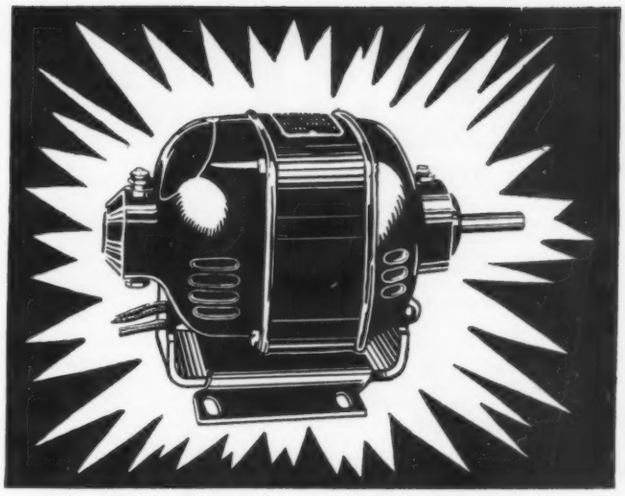
VALVES—Four-way control valves for use in the operation of air-operated reciprocating equipment are described in a bulletin of Q-C Engineering Products, Detroit.

Research Publications

An Experimental Investigation of the Friction of Screw Threads, by Clarence W. Ham and David G. Ryan. Values for coefficients of friction applicable to the present-day operation of power screws were determined by this comprehensive investigation which considered load, speed, lubrication, combination of materials, etc. The type of screws tested may be used either as a means of performing work or for the purpose of binding and holding together various parts of machines or structures. Published as bulletin No. 247 by Engineering Experiment Station, University of Illinois, Urbana, Ill. 60 pp. 35 cents.

Celluloid as a Medium for Photoelastic Investigation, by Robert H. G. Edmonds and Bryan T. McMinn. The physical properties of celluloid and their bearing on its use in the photoelastic method of stress determination are considered in this research. Curves and test data on American-made celluloid show stress-strain and time-creep relations. The results indicate that the physical constants for this material are not fixed, but have a consistent variation with speed of loading. Celluloid is not perfectly elastic under any condition of loading. Some important peculiarities in the interrelation between photoelastic color and stress and a strain are pointed out. Published as bulletin No. 63 by Engineering Experiment station, University of Washington, Seattle, Wash. 21 pp. 25 cents.

White-Metal Bearing Alloys: Mechanical Properties at Different Temperatures and Service Tests, by Harry K. Herschman and John L. Basil. A study was made of the wear resistance and other mechanical properties of 11 white-metal bearing alloys. These include 2 tin-base and 8 lead-base alloys and 1 cadmium-zinc alloy. Each of the properties, with the exception of wear, was determined at several temperatures ranging from 20 to 200 degrees Cent. Crankshaft bearings of four compositions were prepared for service tests in army trucks. These bearings included two tin-base and two lead-base alloys. The results of service tests were consistent with those obtained on wear in the laboratory. Published by bureau of standards. Available through Superintendent of Documents, Government Printing office, Washington. 5 pp. 5 cents.



GANGWAY

The Leland Electric Company is definitely optimistic. An improvement in the general outlook and a further development of the Leland line forecast an upward climb. Time marches on and better days are near again.

In the field of electric refrigeration the Leland cradle-base motor has been established as one of the quietest and most suitable of all available designs.

Its suitability for oil burner, stoker and air conditioning applications has won high commendation.

Its position as a dependable drive for a long list of other appliances is firmly entrenched.

Design Characteristics

Distinguishing features of the Leland cradle base motor include a short-circuiting device capable of many years of dependable service; a simple and positive brush lifter; a continuous, self-filtering lubricating system; a type of mounting that definitely prevents shaft dislocation due to thrust; an exterior appearance that adds measurably to the saleability of the appliance on which it is used.

As we enter upon a new era in business, make it a point to inspect and test this motor. Familiarize yourself with its many distinctive features.

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DAYTON · OHIO · U·S·A

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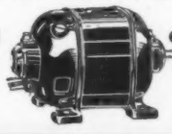

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Leland Motors

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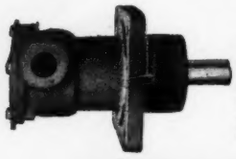

Especially designed for the actuation of machine tool movements and the operation of hydraulic lifts and elevators and all other applications requiring a hydraulic oil pressure up to 500 pounds per square inch. Capacities of 5 to 45 G. P. M.

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Made of the finest laboratory tested metals in capacities of 5, 10, 15, 20 and 35 G. P. M. Built-in relief rotor to act as relief valve when the oil line is shut off. Ports are tapped and plugged to permit changing the direction of rotation.

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MACHINE DESIGN is a monthly technical publication conceived, edited and directed expressly for those executives and engineers responsible for the creation and improvement of machines built for sale, and for the selection of the materials and parts to be used.

Business and Sales Briefs

Russell, Burdsall Ward Bolt & Nut Co., Port Chester, N. Y., has moved its western sales office from 210 South Michigan avenue, Chicago, to its western plant at Rock Falls, Ill. Foster E. Fike, western sales manager, continues in that capacity with headquarters at Rock Falls.

* * *

Reliance Electric & Engineering Co., Cleveland, has announced the appointment of W. W. Spanagel as district manager for the Cleveland territory.

* * *

Scovill Mfg. Co., Waterbury, Conn., has been licensed by Dardelet Threadlock Corp. to manufacture and sell bolts and nuts with self-locking thread.

* * *

Thomas Aurelius has been elected vice president in charge of sales by Colorado Fuel & Iron Co., Denver and Pueblo, Colo.

* * *

Lawrence Pump & Engine Co., Lawrence, Mass., has opened a St. Louis office in the Mart building, Twelfth and Spence streets, under supervision of George Myers.

* * *

Ray Linn, 1432 Jermain drive, Toledo, O., has become associated with Ex-Cell-O Aircraft & Tool Corp., and will represent them in the Toledo territory.

* * *

A. D. Darragh & Co., 17 Battery Place, New York, have been appointed representatives in the New York district in the sale of Z metal castings manufactured by Arcade Malleable Iron Co., Worcester, Mass.

* * *

Pack-Morin Inc., 261 Fifth avenue, New York, has recently organized as a firm of consulting engineers which will offer a complete engineering service covering all phases of plant management including the solution of chemical, metallurgical and mechanical problems.

* * *

Burt F. Stauffer has been appointed general manager of Miller Rubber Products Co. Inc., Akron, O., division of B. F. Goodrich Co. For eight years Mr. Stauffer has been assistant general superintendent of the Goodrich mechanical division.

* * *

Republic Steel Corp., Youngstown, O., has removed its district sales office from Dallas, Tex., to 2322 Gulf building, Houston, Tex. R. E. Lanier, district sales manager, and his staff, have been transferred to Houston and will have charge of the new office.

* * *

Harry J. Fisher, until recently sales manager of Aetna-Standard Engineering Co., Youngstown, O., and who previously handled sales of Reliance motors, has become distributor in Ohio for Clark Controller Co., Cleveland. Mr. Fisher's headquarters are in Cleveland.

* * *

Belden Mfg. Co., Chicago, has licensed the following companies for the manufacture of its unbreakable soft rubber plug: American Steel & Wire Co., Anaconda Wire & Cable Co., Diamond Braiding Mills Inc., Essex Wire Corp., General Cable Corp., National Electric Products Corp., Packard Electric Corp., John A. Roebling Sons' Co., Rockbestos Products Corp., U. S. Rubber Co. The Canadian licensee is Viceroy Mfg. Co. Ltd., Toronto, Ont.

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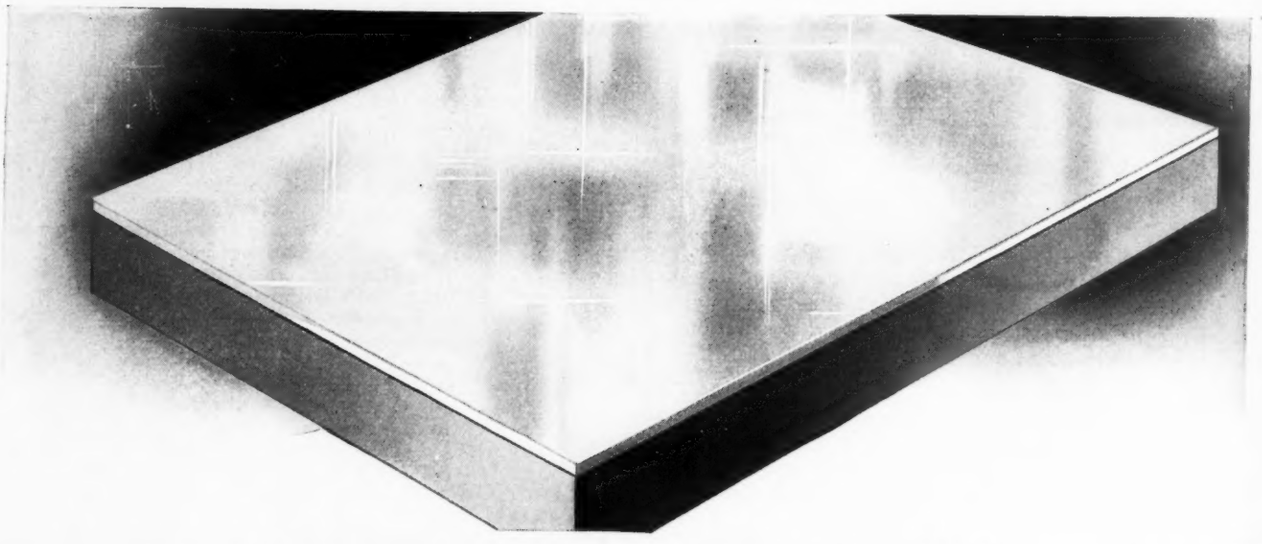

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